Environmental Enrichment Information Resources for Laboratory Animals

1965-1995

Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents

AWIC Resource Series No. 2

ISBN 0 900767 91 X

Environmental Enrichment Information Resources for Laboratory Animals:

1965 - 1995

Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents

September 1995

Contributors:

United States Department of Agriculture
Agricultural Research Service
National Agricultural Library
Animal Welfare Information Center
10301 Baltimore Boulevard
Beltsville, Maryland 20705
USA
Telephone: 301-504-6212
Fax: 301-504-7125

and

Universities Federation for Animal Welfare
8 Hamilton Close
South Mimms
Potters Bar, Hertfordshire EN6 3QD
England
Telephone: 01707 658202
Fax: 01707-649279

Cynthia Petre Smith, M.S.
Tim Allen, M.S.
D'Anna Jensen, B.S.
Michael Kreger, M.S.
Jean Larson, M.A. - Coordinator

Victoria Taylor, B.Sc. - Development Officer
Roger Ewbank, M.V.Sc.
Robert Hubrecht, Ph.D.
Trevor Poole, Ph.D.

Articles contributed by:

Christine Nicol, Ph.D., Bristol University
Sandra McCune, Ph.D., University of Cambridge
Robert Hubrecht, Ph.D., Universities Federation for Animal Welfare
Michael Appleby, Ph.D., University of Edinburgh
Dorothy Einon, Ph.D., University College, London
Debbie Gunn, Ph.D. and David B. Morton, Ph.D. , University of Birmingham
Heleen A. van de Weerd, M.Sc. and Vera Baumans, Ph.D., Utrecht University

National Agricultural Library Cataloging Record:

Environmental enrichment information resources for laboratory animals: 1965-1995.
(AWIC resource series; no. 2)
1. Laboratory animals--Bibliography. 2. Laboratory animals--Handling--Bibliography.
3. Animal Welfare--Bibliography.
I. Smith, Cynthia Petrie. II. Taylor, Victoria. III. Animal Welfare Information Center (U.S.)
IV. Universities Federation for Animal Welfare. V. Title.
aHV4701.A94 no.2

Cover photo by Tim Allen

Contents

Introduction

Environmental Enrichment Information Resources for Laboratory Animals has been produced jointly by the Animal Welfare Information Center (AWIC) of the U.S. Department of Agriculture's National Agricultural Library (NAL) and the Universities Federation for Animal Welfare (UFAW) in an effort to encourage the implementation of environmental enrichment programs in laboratory animal husbandry. This publication covers birds, cats, dogs, farm animals, ferrets, rabbits, and rodents. The exclusion of non-human primates is deliberate as they are covered in a separate AWIC publication, *Environmental Enrichment Information Resources for Nonhuman Primates: 1987-1992.*

Various terms are used to describe the welfare requirements of animals in captivity--"psychological well-being," "ethological" or "behavioral needs," and "environmental enrichment." Whatever the term used, they are essential requirements, not luxuries. Legislation and guidelines in the European Union (EU) and the United States recognize this. The Council Directive of the EU concerning all laboratory animals stipulates that facilities "...should permit the satisfaction of certain ethological needs...." In the United States, the Animal Welfare Act requires facilities to provide exercise for dogs and programs to promote the psychological well-being of non-human primates, while the U.S. Public Health Service *Guide to the Care and Use of Laboratory Animals* encourages "enriching the environment as appropriate to the species...." The literature cited in this bibliography reflects the extent of research that has taken place in the field of environmental enrichment or deprivation. While offering a useful resource, the bibliography also reveals areas that are lacking in basic information. Consequently, for species about which little information exists, we have provided literature sources on natural and captive behaviors as a foundation for the development of enrichment programs.

Each section of this bibliography is introduced by a paper which provides general background information on the biology of the animals and their currently accepted needs in captivity. It is advisable to refer to all of the contributions. This should act as a starting point for those about to embark on an enrichment project and the citations can then provide further relevant information.

The staffs of the Animal Welfare Information Center and the Universities Federation for Animal Welfare hope that you find this publication to be a useful addition to your laboratory animal resources and welcome any comments for furure editions.

How To Use This Document

This publication is divided into 8 sections: articles and bibliographies, journal listing, subscription information for selected journals, organizations, suppliers and products, common devices and programs, subject index, and document delivery information for U.S. and foreign patrons.

Articles and Bibliographies

The primary section of this publication consists of seven subsections broken out by species or class of animal. Each subsection is introduced by an article written by a recognized authority in the field of environmental enrichment or behavior. The reference section for each article may or may not overlap with citations in the bibliographic portion of each subsection. Immediately following each article is a comprehensive bibliography containing citations that are arranged alphabetically according to the last name of the primary author. Each entry also contains descriptors and the NAL Call Number if the particular source is available at the National Agricultural Library (NAL).

Journal Listing

This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

Subscription Information for Selected Publications

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

Organizations

There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addresses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

Suppliers and Products

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means exhaustive, listing of commercial vendors and the enrichment products they supply. This listing include items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

Common Devices and Programs

In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

Subject Index

The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *page number* on which the index term can be found.

Document Delivery Information

The information contained here provides directions on how to obtain copies of articles mentioned in the bibliography. There are separate directions for U.S. patrons and those readers outside the United States. **All patrons are encouraged to use their local resources before contacting the National Agricultural Library.** While the National Agricultural Library provides a variety of services to patrons around the world, videocassettes are not available for loan outside the United States and Canada.

Birds

Environmental Enrichment for Birds

Christine Nicol
Department of Clinical Veterinary Science,
Bristol University, Langford House, Bristol BS18 7DU, UK

Introduction

Birds of many different species from a wide variety of original habitats are housed in research laboratories. Galliformes such as the quail (*Coturnix coturnix*) and the chicken (*Gallus gallus*) are used in biomedical research in studies of reproductive, digestive and "biological clock" physiology, and in genetic research. Pigeons (*Columba livia*) are stalwarts of the psychological laboratory, used primarily for learning and cognitive studies, whilst diverse species such as budgerigars (*Melopsittacus undulatus*), starlings (*Sturnis vulgaris*) and passerine species (e.g., the great tit, *Parus major*) may also be kept for behavioral research purposes. This diversity makes it difficult to generalize about the specific physical or behavioral needs of laboratory birds, and a preliminary first step should always be to consider the natural behavior of each species in the wild.

Wild quail and jungle fowl (the ancestor of the domestic fowl) live in small social groups, devote much of their day to scratching and foraging for food on the ground, and perform complex sequences of behavior such as dustbathing and pre-laying nesting. In the laboratory they may be housed in aviaries or floor pens, or in cages with varying opportunity to perform these behavioral patterns. The spatial restriction imposed by typical laboratory chicken (50 x 60 x 56cm high) or quail (27 x 36 x 20cm high) cages may restrict even relatively simple movements such as wing-flapping. The pigeon is a more gregarious bird, often found in very large flocks, and capable of flying fast over distances of more than 1000km. In the laboratory pigeons are kept either in aviaries, pigeon lofts, or in cages (typically 44 x 44 x 54cm high).

In most laboratories veterinary supervision is good and careful attention is devoted to hygiene, and to the maintenance of strict temperature and lighting regimes. Despite this care, the welfare of many laboratory birds may be prejudiced in barren or restrictive environments. This may be a particular oversight when the birds are subjects of behavioral or psychological research, as there is some evidence that cognitive abilities may be detrimentally affected by barren housing. It is probably not possible to recreate a completely natural environment for all laboratory birds, but much can be achieved by relatively simple environmental enrichment, especially in conjunction with information about behavioral needs and priorities.

More is known about the welfare requirements of the domestic fowl than any other bird, largely because of research generated by the controversy over agricultural battery cages. Caution is required when generalizing across species, but a number of important points have emerged from this research, relating to both physical and mental well-being, that can be applied to the laboratory situation.

Laying hens are alarmingly prone to bone breakage if they fly into solid structures such as cage walls, or poorly positioned perches. The risk of breakage is exacerbated if bones are weak due to insufficient exercise in spatially restricted housing. Most cages for laboratory birds appear to allow sufficient space for wing stretching, if not for flapping or actual flight, but many birds may avoid stretching their limbs too close to solid walls or partitions. The greatest risk of physical injury will occur if birds become frightened and attempt to escape from their cages, either during catching procedures or simply when disturbed by human presence. It is therefore important to allow sufficient space for running and wing flapping to maintain bone strength, and because these are important behaviors in their own right (Nicol 1987). This freedom must be coupled with the provision of a small, safe catching area. Birds can often be enticed into such areas if they are well lit whilst the rest of the room is temporarily darkened. Protection from injury can also be facilitated by suspending protective nets just below the cage or aviary roof or by lining the cage or catching area (e.g., with fiberglass) and ensuring there are no rough projections.

If fear levels in laboratory-housed birds are low then panic flights leading to physical injury are less likely, and general welfare is improved. New birds should be gradually exposed to the specific sounds or stimuli that they will encounter in the laboratory so that they can habituate. Research on many species, including chickens and quail, has also shown that baseline fear levels can be reduced by providing an enriched environment. Rearing young birds with access to a variety of stimuli such as colored objects and background music appears to have long-term beneficial effects. But, for adult birds, environmental enrichment must do more than simply provide a more complex general environment. It must also provide opportunities for birds to perform high priority behavior patterns. Increasing evidence suggests that functional behavior performance is crucial to good welfare. Even when birds are provided with *ad libitum* food and pre-formed nests, they still need to perform foraging and nest-building behavior. Laying hens are even willing to "pay a cost" to obtain their food by foraging in litter, rather than eat readily available food from a dish.

Recommendations

Some simple suggestions for the environmental enrichment of laboratory birds include:

1. Allow birds to forage for their food (which should be as varied as possible), either by scattering the food in wood-shavings on the aviary floor, by hiding it amongst shredded paper in a large trough, or by providing it in a form where birds have to work e.g., stuck together in a grain-block. Operant feeders, where a button must be pecked to release food, may occupy solitary birds, but cannot be recommended for group-housed birds as they may not allow birds to feed simultaneously and hence could result in increased competition and risk of feather pecking.

2. Allow egg-laying birds the opportunity to perform nesting behavior by the provision of suitable nest-boxes and building material. If hen or quail have to be kept in cages consider the possibility of modifying the cage to incorporate a roll-away nest box. This can work successfully for laying hens housed in cages (Sherwin 1994).

3. Allow sufficient space for running or flying activity, and consider ways of increasing the value of the space available. Perches or roosting shelves can be incorporated cheaply into all housing systems. In small cages perches can be inserted at night to allow roosting but removed during the day to allow unrestricted space.

4. House birds in suitable stable social groups. If birds must be housed individually arrange the cages so that they have visual contact with others. This may reduce the incidence of stereotypic behavior (Keiper 1970). Since birds seem able to perceive 2-dimensional images the use of mirrors may also reduce the negative effects of social isolation.

References

Keiper, R.R. (1970) **Studies of stereotypy function in the canary *(Serinus canarius).*** *Animal Behaviour 18:*353-357.

Nicol, C.J. (1987) **Behavioural responses of laying hens following a period of spatial restriction.** *Animal Behaviour 35:*1709-1719.

Sherwin, C.M. (ed) (1994) **Modified cages for laying hens.** Universities Federation for Animal Welfare: Potters Bar.

Bird Bibliography

Alvey, D.M. and S.A. Tucker (1994). **Cage design and laying hen welfare.** In: *Modified cages for laying hens. Proceedings of a symposium held at Noble House, London, UK, 18th January 1993* C.M. Sherwin, ed., UFAW: Potters Bar, UK, pp. 55-61.
NAL call number: SF494.5 M63 1994
Descriptors: chickens, laying hens, caging, depopulation, caging material, feather abrasion, cage floors, perches, economic consequences.

Alvey, D.M. and S.A. Tucker (1994). **Effect on egg production of incorporating a perch within a battery cage.** *British Poultry Science* 35(1):176-177.
NAL call number: 47.8 B77
Descriptors: perch, housing, laying hens, egg production.

Anderson, K.E. and A.W. Adams (1989). **Effects of restricted waterer, feeder and floor space per bird on growth and feed consumption of cage reared white leghorn pullets.** *Poultry Science* 68(Supplement 1):3.
NAL call number: 47.8 Am33P
Descriptors: density, hens, water restriction, space, drinking, production.

Anderson, K.E., A.W. Adams, and J.V. Craig (1989). **Behavioral adaptation of floor-reared white leghorn pullets to different cage densities and cage shapes during the initial settling-in period.** *Poultry Science* 68(1):70-78.
NAL call number: 47.8 AM33P
Descriptors: pullets, density, comfort, behavior, cage, floor pens.

Anon. (1979). **Chickens.** In: *Comfortable Quarters for Laboratory Animals*, Washington, D.C.; Animal Welfare Institute, pp. 98-101.
NAL call number: SF91.A5 1979
Descriptors: facilities, cage, housing, laboratories.

Appleby, M.C. (1992). **Behaviour-environment interactions in hens: Implications for housing.** *Animal Production* 54(3):470.
NAL call number: 49 AN55
Descriptors: space, pre-laying behavior, dustbathing, housing, behavior, hens.

Appleby, M.C. (1990). **Behaviour of laying hens in cages with nest sites.** *British Poultry Science* 31(1):71-80.
NAL call number: 47.8 B77
Descriptors: behavior, hens, cage, substrate, rollaway hollow, space.

Appleby, M.C. (October 1984). **Factors affecting floor laying by domestic hens: A review.** *World's Poultry Science Association* 40(3):241-249.
NAL call number: 47.8 W89
Descriptors: production, floor type, housing, hens, nest sites.

Appleby, M.C. and B.O. Hughes (July 1991). **Welfare of laying hens in cages and alternative systems: Environmental, physical and behavioural aspects.** *World's Poultry Science Journal* 47(2):109-128.
NAL call number: 47.8 W89
Descriptors: welfare, housing density, crowding, floor space, behavior, group size, cage size, bone strength.

Appleby, M.C. and B.O. Hughes (1990). **Cages modified with perches and nests for the improvement of bird welfare.** *World's Poultry Science Journal* 46(1):38-40.
NAL call number: 47.8 W89
Descriptors: dustbath box, nest box, group size, bone strength.

Appleby, M.C., B.O. Hughes, and G.S. Hogarth (1989). **Behaviour of laying hens in a deep litter house.** *British Poultry Science* 30(3):545-554.
NAL call number: 47.8 B77
Descriptors: stocking density, litter, slat floor, foraging, behavior, hens.

Appleby, M.C., S.N. Maguire, and H.E. McRae (1986). **Nesting and floor laying by domestic hens in a commercial flock.** *British Poultry Science* 27(1):75-82.
NAL call number: 47.8 B77
Descriptors: cage, deep litter pen, nest box, preference, hen, flock.

Appleby, M.C. and S.F. Smith (1991). **Design of nest boxes for laying cages.** *British Poultry Science* 32(4):667-678.
NAL call number: 47.8 B77
Descriptors: wire floor nest box, rollaway nest box, egg production, nesting behavior, space, cage, nest box, hens.

Appleby, M.C., S.F. Smith, and B.O. Hughes (1992). **Individual perching behaviour of laying hens and its effects in cages.** *British Poultry Science* 33(2):227-238.
NAL call number: 47.8 B77
Descriptors: perch-type preference, perch space, egg quality, crowding, behavior, perch, hens, cage.

Blokhuis, H.J. (August 1986). **Feather-pecking in poultry: Its relation with ground pecking.** *Applied Animal Behaviour Science* 16(1):63-67.
NAL call number: QL750.A6
Descriptors: housing, floor type, feather pecking.

Blokhuis, H.J., J.W. Van der Haar, and P.G. Koole (1987). **Effects of beak trimming and floor type on feed consumption and body weight of pullets during rearing.** *Poultry Science* 66(4):623-625.
NAL call number: 47.8 AM33P
Descriptors: floor, substrate, pullets, debeaking, feeding.

Bolhuis, J.J. and W.J. Trooster (June 1988). **Reversibility revisited: Stimulus-dependent stability of filial preference in the chick.** *Animal Behaviour* 36(3):669-674.
NAL call number: 410 B77
Descriptors: filial preference, behavior, stimuli.

Bonner, J. (March 1991). **Battery cages are "better for hens."** *New Scientist* 129(1759):17.
NAL call number: 472 N42
Descriptors: battery cage, percheries, confinement, exercise, disease.

Brake, J. (1993). **Influence on nest pad color on nest preference floor eggs and egg production.** *Poultry Science* 72(Supplement 1):156.
NAL call number: 47.8 AM33P
Descriptors: laying hens, nest pad, preference, egg production.

Chidananda, B.L., K.S. Prathapkumar, P.V. Sreenivasaiah, G.R. Lokanath, and B.S. Ramappa (Sept. 1985). **Comparative performance of Japanese quail on cage and deep litter. 1. Body weight, feed efficiency and mortality.** *Indian Journal of Poultry Science* 20(3):162-164.
NAL call number: SF481.I5
Descriptors: quail, cage, litter, mortality, feed efficiency, mortality.

Chidananda, B.L., K.S. Prathapkumar, P.V. Sreenivasaiah, B.S. Ramappa, and G.R. Lokanath (June 1986). **Comparative performance of Japanese quail on cage and deep litter. 2. Egg production and reproduction traits.** *Indian Journal of Poultry Science* 21(2):91-96.
NAL call number: SF481.I5
Descriptors: quail, cage, litter, production, reproduction.

Church, J.S., T. Tennessen, and A.B. Webster (1992). **Environmental enrichment influences on body weight, feathering, foot condition and behaviour of caged white leghorn hens.** *Journal of Animal Science* 70(Supplement 1):175.
NAL call number: 49 J82
Descriptors: fear, stress, battery cages, cage enrichment, cage, hens, body weight, behavior.

Church, J.S., T. Tennessen, and A.B. Webster (1991). **Effects of environmental enrichment and genetic strain on the behaviour of white leghorn pullets.** *Canadian Journal of Animal Science* 71(4):1274.
NAL call number: 41.8 C163
Descriptors: battery cages, breeds, production, cage, pullets, genetics, behavior.

Craig, J.V. and J.A. Craig (May 1985). **Corticosteroid levels in White Leghorn hens as affected by handling, laying house environment, and genetic stock.** *Poultry Science* 64(5):809-816.
NAL call number: 47.8 AM33P
Descriptors: handling, housing, genetics, hens.

Craig, J.V. and G.A. Milliken (Jan. 1989). **Further studies of density and group size effects in caged hens of stocks differing in fearful behavior: Productivity and behavior.** *Poultry Science* 68(1):9-16.
NAL call number: 47.8 AM33P
Descriptors: density, hens, fear, egg production, behavior.

Craig, J.V. and J.C. Swanson (1994). **Review: Welfare perspectives on hens kept for egg production.** *Poultry Science* 73(7):921-938.
NAL call number: 47.8 Am33P
Descriptors: chickens, hens, alternative production systems, economic consequences.

Craig, J.V. and S.M. Muir (1986). **Fear and feather loss of hens in 3-bird cages: Associations with other traits.** *Poultry Science* 65(Supplement 1):28.
NAL call number: 47.8 AM33P
Descriptors: tonic immobility, avoidance behavior, production, hen, 3-bird cage.

Craig, J.V., N.A. Okpokho, and G.A. Milliken (1988). **Floor and cage-rearing effects on pullets' initial adaptation to multiple-hen cages.** *Applied Animal Behaviour Science* 20(3-4):319-334.
NAL call number: QL750.A6
Descriptors: feeding, feather-pecking, pullet, cage, floor pen, density.

Craig, J.V. and N.C. Ramos (August 1986). **Competitive feeding behavior and social status in multiple-hen cages.** *Applied Animal Behaviour Science* 16(1):69-76.
NAL call number: QL750.A6
Descriptors: competitive, feeding, aggression, dominance, submission, social, cage.

Craig, J.V., J. Vargas Vargas, and G.A. Milliken (December 1986). **Fearful and associated responses of white leghorn hens: Effects of cage environments and genetic stocks.** *Poultry Science* 65(12):2199-2207.
NAL call number: 47.8 AM33P
Descriptors: cage, hens, genetics, tonic immobility, density, corticosteroids, production, mortality.

Cunningham, D.L. and G. Gvaryahu (October 1987). **Effects on productivity and aggressive behavior of laying hens of solid versus wire cage partitions and bird density.** *Poultry Science* 66(10):1583-1586.
NAL call number: 47.8 AM33P
Descriptors: cage partitions, aggression, hens, density.

Cunningham, D.L., A. Van Tienhoven, and F. de Goeijen (April 1987). **Dominance rank and cage density effects on performance traits, feeding activity and plasma corticosterone levels of laying hens (*Gallus domesticus*).** *Applied Animal Behaviour Science* 17(1/2):139-154.
NAL call number: QL750.A6
Descriptors: hens, dominance, feeding behavior, density.

Davis, D.S. and H.A. Allen, Jr. (1989). **An improved waterfowl enclosure: Considering animal welfare as a research priority.** *Journal of Field Ornithology* 60(2):162-167.
NAL call number: 413.8 B534
Descriptors: care, housing, design, captivity, waterfowl, welfare.

Dawkins, M. (1977). **Do hens suffer in battery cages? Environmental preferences and welfare.** *Animal Behaviour* 25(4):1034-1046.
NAL call number: 410 B77
Descriptors: battery cage, habitat preference, hen-run, pen, indicators of suffering, previous environmental experience, latency period.

Duncan, I.J.H. (1992). **The effects of the researcher on the behavior of poultry**. In: *The Inevitable Bond: Examining Scientist-Animal Interactions* H. Davis and D. Balfour, eds., Cambridge University Press: Cambridge, England, pp. 285-294.
NAL call number: QL55.I44
Descriptors: human contact, fear, observer effect, habituation.

El-Homosany, Y.M., J.A. Mench, M.F. Ali (1994). **Effects of group size and floor space on the well-being of female Japanese quail**. *Poultry Science* 73(Supplement 1):57.
NAL call number: 47.8 Am33P
Descriptors: Japanese quail, housing, social groups, density, egg production.

Faure, J.M. (1986). **Operant determination of the cage and feeder size preferences of the laying hen**. *Applied Animal Behaviour Science* 15(4):325-336.
NAL call number: QL750.A6
Descriptors: cage, hens, feeder, apparatus, motivation, production.

Faure, J.M. (1985). **Space need for domestic hens in cage.** *Biology of Behaviour* 10(4):343-351.
NAL call number: QL750 B52
Descriptors: operant conditioning, feeder size, demand elasticity, behavior, space, hen, cage.

Gernat, A.G. and A.W. Adams (1990). **Effect of number and location of nipple waterers and cage shape on the performance of caged layers**. *Poultry Science* 69(12):2086-2091.
NAL call number: 47.8 AM33P
Descriptors: dome water, trigger cup water, deep cage, shallow cage, mortality, egg production, water, cage, hens.

Gibson, S.W., B.O. Hughes, S. Harvey, and P. Dun (1986). **Plasma concentrations of corticosterone and thyroid hormones in laying fowls from different housing systems**. *British Poultry Science* 27(4):621-628.
NAL call number: 47.8 B77
Descriptors: cage, range, straw yard, stress, housing, hens, hormones.

Gill, E.L. (August 1994). **Environmental enrichment for captive starlings.** *Animal Technology: Journal of the Institute of Animal Technology* 45(2):89-93.
NAL call number: QL55.I5
Descriptors: sturnus vulgaris, animal welfare, foraging, cocoa husks, calliphora vomitoria, laboratory rearing.

Gill, J.L. (1989). **Statistical aspects of design and analysis of experiments with animals in pens.** *Journal of Animal Breeding and Genetics* 106(5):321-334.
NAL call number: 442.8 Z35
Descriptors: statistical design, animal number, blocking, experimental units, split-plot design.

Gordon, S.H. (1992). **The effect of broiler stocking density on bird welfare and performance.** *British Poultry Science* 33(5):1120-1121.
NAL call number: 47.8 B77
Descriptors: housing, substrate, flock management, production, broilers, welfare.

Granza, A.F. (1970). **Vocal mimicry in captive budgerigars (*Melopsittacus undulatus*).** *Zeitschrift für Tierpsychologie* 27(8):971-983.
NAL call number: 410 Z35
Descriptors: learning, acoustic enrichment, play behavior, toys, budgerigars.

Gross, W.B. (1983). **Chicken-environment interactions.** In: *Ethics and Animals*, H.B. Miller and W.H. Williams (eds.), Clifton, N.J.; Humana Press pp. 329-337.
NAL call number: HV4711.E87
Descriptors: rearing environment, lumination, handler influence, social groups.

Gschwindt-Ensinger, B. (1986). **The effect of different housing systems on several stress relevant physiological parameters.** *Archiv für Gefluegelkunde* 50(1):13-19.
NAL call number: 47.8 AR2
Descriptors: floor pen, cage, body weight, antibody titers, blood lipids, carbohydrates, stress, physiological, hen, housing.

Gvaryahu, G., D.L. Cunningham, and A. Van Tienhoven (1989). **Filial imprinting, environmental enrichment and music application: Effects on behaviour and performance of meat strain chicks.** *Poultry Science* 68(2):211-217.
NAL call number: 47.8 AM33P
Descriptors: broiler chicks, fear, feeding, approach, Classical music.

Hemsworth, P.H., J.L. Barnett, and R.B. Jones (1993). **Situational factors that influence the level of fear of humans by laying hens.** *Applied Animal Behaviour Science* 36(2-3):197-210.
NAL call number: QL750.A6
Descriptors: tier housing system, battery cage, cage, hens, productivity, fear.

Huber, L. (1994). Amelioration of laboratory conditions for pigeons (*Columba livia*). *Animal Welfare* 3:321-324.
NAL call number: HV4701 A557
Descriptors: animal welfare, conditioning, learning tests, housing, Skinner box.

Huber, H.U., D.W. Folsch, and U. Stahli (1985). **Influence of various nesting materials on nest site selection of the domestic hen.** *British Poultry Science 26(3):367-374.*
NAL call number: 47.8 B77
Descriptors: deep litter system, cage, nest material, preferences, nest site, hen.

Hughes, B.O., I.J.H. Duncan, and M.F. Brown (1989). **The performance of nest building by domestic hens: Is it more important than the construction of a nest?** *Animal Behaviour* 37(2):210-214.
NAL call number: 410 B77
Descriptors: hens, behavior performance, motivation, nest building.

Hulet, R.M., D.M. Denbow, and R.W. Manley (1991). **Effect of bird density on growth performance of cage-brooded male and female turkeys**. *Poultry Science* 70(Supplement 1):54.
NAL call number: 47.8 AM33P
Descriptors: group size, body weight, industry, turkeys, cage.

Hurnik, J.F. and N.J. Lewis (February 1991). **Body surface area, a reference for space allowance in confinement** *Poultry Science* 70(2):412-415.
NAL call number: 47.8 AM33P
Descriptors: resting behavior, comfort, space, surface area.

Hypes, W.A., R.A. Peterson, G.H. Carpenter, and W.T. Jones (1992). **Environmental stress evaluation of floor and high density cage brooded broiler chicks.** *Poultry Science* 71(Supplement 1):127.
NAL call number: 47.8 AM33P
Descriptors: crowding, immunosuppression, heterophil-lymphocyte ratio, housing, chicks, cage.

Ishimoto, Y., T. Yamazaki, K. Kondo, and C. Yamashita (October 1982). **Effect of cage shapes and colony size on layer performance. II. Chicken housing.** *Research Bulletin of the Aichi-Ken Agricultural Research Center [Aichi-ken Nogyo Sogo Shikenjo kenkyu hokoku]* 14:421-425.
NAL call number: S19 R42
Descriptors: cage, shape, colony size, performance.

Jin, L. and J.V. Craig (October 1988). **Some effects of cage and floor rearing on commercial White Leghorn pullets during growth and the first year of egg production.** *Poultry Science* 67(10):1400-1406.
NAL call number: 47.8 AM33P
Descriptors: growth, genetics, behavior, cage, production.

Jones, R.B. (June 1989). **Development and alleviation of fear in poultry.** *The Proceedings of the Third European Symposium on Poultry Welfare, Tours, France: 11-14th June 1989,* J-M. Faure and A.D. Mills, eds., The French Branch of the World's Poultry Science Association with European Federation of the World's Poultry Science Association's Working Group 9 on Poultry Welfare.
NAL call number: HD9437 E9 1989
Descriptors: fear alleviation, ontogeny, welfare, performance, behavior.

Jones, R.B. (November 1989). **Fear in poultry.** *The Proceedings of the BVA Animal Welfare Foundations's Eighth Symposium: The Detection and Control of Fear in Animals, 9 November 1989*, T.E. Gibson, ed., BVA Animal Welfare Foundation.
NAL call number: HV4704 A54 1989
Descriptors: fear, poultry, consequences, alleviate, behavior, adapt, novel, tonic immobility, handling, cage, cannibalism, socialization, artificial selection, welfare, performance, environmental enrichment.

Jones, R.B. (1986). **Responses of domestic chicks to novel food as a function of sex, strain and previous experience.** *Behavioural Processes* 12:261-271.
NAL call number: QL750 B4
Descriptors: food neophobia, novel, chicks, environmental enrichment, fear, genetic factors, strain, sex, experiential factors, dietary diversity.

Jones, R.B. (February1986). **The tonic immobility reaction of the domestic fowl: A review.** *World's Poultry Science Journal* 42(1):82-96.
NAL call number: 47.8 W89
Descriptors: tonic immobility, handling, dominance, genetics, age, stress, fowl.

Jones, R.B. (1985). **Fearfulness and adaptability in the domestic fowl.** *IRCS (International Research Communications System) Medical Science* 13(9):797-800.
NAL call number: R5 J6
Descriptors: tonic immobility, handling, genetics, environmental enrichment, fowl, fear, performance, welfare, egg production, cage, adapt.

Jones, R.B. (1985). **Fearfulness of hens caged individually or in groups in different tiers of a battery and the effects of translocation between tiers.** *British Poultry Science* 26(3):399-408.
NAL call number: 47.8 B77
Descriptors: tonic immobility, tier system, avoidance, novel objects, hen, cage, translocation.

Jones, R.B. (1982). **Effects of early environmental enrichment upon open-field behavior and timidity in the domestic chick.** *Developmental Psychobiology* 15(2):105-111.
NAL call number: QP351 D4
Descriptors: environmental enrichment, fear, novel, behavior, open field, timidity, emergence latency.

Jones, R.B., S. Harvey, B.O. Hughes, and A. Chadwick (1980). **Growth and the plasma concentrations of growth hormone and prolactin in chicks: Effects of "environmental enrichment," sex and strain.** *British Poultry Science* 21:457-462.
NAL call number: 47.8 B77
Descriptors: novel objects, environmental enrichment, plasma growth hormone, prolactin, chicks, sex, strain, weight gain, gain-to-food ratio.

Jones, R.B., A.D. Mills, and J-M. Faure (1991). **Genetic and experimental manipulation of fear-related behavior in Japanese quail chicks (*Coturnix coturnix japonica*).** *Journal of Comparative Psychology* 105(1):15-24.
NAL call number: BF671 J6
Descriptors: tonic immobility, handling, environmental enrichment, activity, vocalizations, quail, genetics, fear.

Jones, R.B., A.D. Mills, and J-M. Faure (1990). **Genetic selection, environmental enrichment, and regular handling can alleviate fear in Japanese quail.** *Poultry Science* 69(Supplement 1):70.
NAL call number: 47.8 AM33P
Descriptors: handling, fear, quail, tonic immobility, genetics, behavior, breeding.

Jones, R.B. and D. Waddington (June 1992). **Modification of fear in domestic chicks, *Gallus gallus domesticus*, via regular handling and early environmental enrichment.** *Animal Behaviour* 43(6):1021-1033.
NAL call number: 410 B77
Descriptors: novel object, bird-human interaction, behavior, habituation, tonic immobility, chicks, fear, welfare, performance, handling.

Kaytasov, G., T. Stojanchev, and G. Boychev (1987). **A study of productivity of broilers reared in battery cages and on deep litter**. *Zhivotnovudni Nauki* 24(3):39-43.
Descriptors: body weight, broilers, cages, feed efficiency, breast blisters, production.

Keeling, L.J. and I.J.H. Duncan (1988). **Relationship between inter-bird distances and available space in laying hens.** *British Poultry Science* 29(4):874.
NAL call number: 47.8 B77
Descriptors: behavior, hens, density, housing, dominance, space.

Keeling, L.J. and J.F. Hurnik (1993). **Chickens show socially facilitated feeding behaviour in response to a video image of a conspecific.** *Applied Animal Behaviour Science* 36(2-3):223-231.
NAL call number: QL750.A6
Descriptors: feed consumption, pecks, social behavior, stimulus, behavior.

Keiper, R.R. (1969). **Causal factors of stereotypies in caged birds.** *Animal Behaviour* 17(1):114-119.
NAL call number: 410 B77
Descriptors: stereotypies, cage size, hand-rearing, wild, social environments, food access, perch, behavior.

Keymer, I.F. **(1987). The canary and other passerine cage birds.** *The UFAW Handbook on the Care and Management of Laboratory Animals*, 6th ed, T.B. Poole (ed.), Longman, London. pp. 687-700.
NAL call number: QL55.U5 1987
Descriptors: laboratory methods, disease control, canary.

King, C.E. (1993). **Environmental enrichment: Is it for the birds?** *Zoo Biology* 12(6):509-512.
NAL call number: QL77.5 Z6
Descriptors: comparison, birds, mammals, primates, environmental enrichment.

King, C.E. (1992). **Parrot wellbeing. Does it deserve more attention?** *Psitta Scene* 4(2):7-8.
Descriptors: care, housing, welfare, psychology, parrot, wellbeing.

Koelkebeck, K.W., J.R. Cain, and M.S. Amos, Jr. (1986). **Corticosterone sampling of laying hens in different management systems.** *Poultry Science* 65(1):183-185.
NAL call number: 47.8 AM33P
Descriptors: stress, battery cage, floor pen, endocrinology, corticosterone, hen, management.

Koelkebeck, K.W., J.R. Cain, and M.S. Amos, Jr. (October 1986). **Use of adrenocorticotropin challenges to indicate chronic stress responses of laying hens in several housing alternatives.** *Domestic Animal Endocrinology* 3(4):301-305.
NAL call number: QL868.D6
Descriptors: hens, stress, housing, corticosterone, corticotropin.

Kovach, J.K. (September 1983). **Constitutional biases in early perceptual learning. I. Preferences between colors, patterns, and composite stimuli of colors and patterns in genetically manipulated and imprinted quail chicks (*Coturnix coturnix japonica*).** *Journal of Comparative Psychology* 97(3):226-239.
NAL call number: BF671 J6
Descriptors: perception, preference, color, pattern, stimuli, imprint.

Kreger, M.D. (1995). ***Housing, Husbandry, and Welfare of Poultry: January 1992-January 1995***. *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 67p.
NAL call number: aZ5071.N3 no. 95-05
Descriptors: husbandry, bibliography, housing, behavior, physiology.

Kreger, M.D. (1994). ***Housing, Husbandry, and Welfare of Selected Birds (Quail, Pheasant, Finches, Ostrich, Dove, Parrot): December 1980-December 1993***. *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 30p.
NAL call number: aZ5071.N3 no.94-26
Descriptors: husbandry, bibliography, housing, behavior, physiology.

Lee, H-Y. and J.V. Craig (February1991). **Beak trimming effects on behavior patterns, fearfulness, feathering and mortality among three stocks of white leghorn pullets in cages or floor pens.** *Poultry Science* 70(2):211-221.
NAL call number: 47.8 AM33P
Descriptors: crowding, cannibalism, tonic immobility, pecking, weight gain, pullets, fear.

Leighton, A.T. Jr., D.M. Denbow, and R.M. Hulet (1985). **Behavior and growth parameters of large white turkeys as affected by floor space and beak trimming.** *Poultry Science* 64(3):440-446.
NAL call number: 47.8 AM33P
Descriptors: age, feed consumption, feed efficiency, feather scores, mortality, aggression, social behavior, turkey, floor space, beak trimming.

Martin, S.G., J.R. Millam (May 1995). Nest box selection by floor laying and reproductively naive captive cockatiels (*Nymphicus hollandicus*). Applied Animal Behaviour Science 43(2):95-109.
NAL call number: QL750.A6
Descriptors: cockatiels, preference testing, nest box, reproduction, behavior

Meijsser, F.M. and B.O. Hughes (December 1989). **Comparative analysis of pre-laying behaviour in battery cages and in three alternative systems.** *British Poultry Science* 30(4):747-760.
NAL call number: 47.8 B77
Descriptors: perchery, deep litter, covered straw yard, battery cage, nesting, cage, hens, behavior.

Mench, J. (1994). **Environmental enrichment and exploration.** *Lab Animal* 23(4):38-41.
NAL call number: QL55 A1L3
Descriptors: laboratory animals, chickens, behavior, exploratory behavior, devices, age, sex, social context, genetics, experience.

Mench, J. (1986). **Cage design for layers.** *Poultry Digest* 45(533):273.
NAL call number: 47.8 N219
Descriptors: feed consumption, egg quality, stress, drinking, plumage condition, cage, layers, design.

Mou, L.J. and N. Kolstad (1990). **Effects of different environments and selection for persistency in laying hens. I. Effects of two different rearing systems on growth rate, feed conversion, mortality and age at sexual maturity in chickens.** *Norwegian Journal of Agricultural Sciences* 4(3):195-204.
NAL call number: S3 N672
Descriptors: battery cage, floor pen, weight gain, heritability, cage.

Murphy, L.B. (1994). **Examples of species-specific considerations in the design of an environment- domestic fowl.** In: *Improving the Well-being of Animals in the Research Environment: Proceedings of the conference held at the Marriott Hotel, Sydney, October, 1993* R.M. Baker, G. Jenkin, and D.J. Mellor, eds., ANZCCART, PO Box 19, Glen Osmond, SA, 5064, Australia, pp. 119-121.
Descriptors: laying hens, broilers, substrate, mesh size, pecking targets, perches.

Nagarajan, S., D. Naraharp, and I.A. Jayaprasad (1990). **Laying performance of Japanese quail hens under different stocking densities.** *Indian Journal of Animal Sciences* 60(12):1467-1470.
NAL call number: 41.8 IN22
Descriptors: cage space, egg production, feed efficiency, mortality, quail, cage.

Na-Lampang, P. and J.V. Craig (June 1990). **Cage- and floor-rearing effects on productivity, nervousness, feather condition, and livability of White Leghorn layers.** *Poultry Science* 69(6):902-909.
NAL call number: 47.8 AM33P
Descriptors: mortality, productivity, hens, feather condition, cages, floor pen.

Na-Lampang, P. and J.V. Craig (October 1990). **Cage-rearing and floor-rearing effects on subsequent behavior of white leghorn layers in multiple-bird cages.** *Poultry Science* 69(10)1652-1658.
NAL call number: 47.8 AM33P
Descriptors: preening, feeding, pecking, genetics, cage, hens.

Na-Lampang, P. and J.V. Craig (1989). **Rearing environment effects on behavior of white leghorn layers in multiple-hen cages.** *Poultry Science* 68(Supplement 1):102.
NAL call number: 47.8 AM33P
Descriptors: density, genetics, hens, industry.

Nicol, C.J. (June 1992). **Effects of environmental enrichment and gentle handling on behaviour and fear responses of transported broilers.** *Applied Animal Behaviour Science* 33(4):367-380.
NAL call number: QL750.A6
Descriptors: tonic immobility, handling, transport, activity, fear, behavior, broilers.

Nicol, C. (March 1990). **Behaviour requirements within a cage environment.** *World's Poultry Science Journal* 46(1):31-33.
NAL call number: 47.8 W89
Descriptors: nesting, laying, feeding, hens, behavior.

Nicol, C.J. (1987). **Behavioural responses of laying hens following a period of spatial restriction.** *Animal Behaviour* 35(6):1709-1719.
NAL call number: 410 B77
Descriptors: space, spatial allowance, behavior, single housing, activity rebound, welfare.

Nicol, C.J. (1987). **Effect of cage height and area on the behavior of hens housed in battery cages.** *British Poultry Science* 28(2):327-336.
NAL call number: 47.8 B77
Descriptors: cage, hens, behavior, pecking, motivation, comfort, feeding.

Nicol, C.J. (1986). **Non-exclusive spatial preference in the laying hen.** *Applied Animal Behaviour Science* 15(4):337-350.
NAL call number: QL750.A6
Descriptors: motivation, cage, floor area, time, hens, space.

Nicol, C.J. and T. Guilford (1990). **Exploratory activity as a measure of motivation in deprived hens.** *Animal Behaviour* 41(2):333-341.
NAL call number: 410 B77
Descriptors: motivation, exploratory activity, deprivation, behavior, activity, tunnel behavior.

Nicol, C.J. and S.J. Pope (1993). **A comparison of the behaviour of solitary and group housed budgerigars.** *Animal Welfare* 2:269-277.
NAL call number: HV4701 A557
Descriptors: budgerigars, behavior, social isolation, group housing, cage, aviary, novel chamber, neophobia, handling.

Norgaard-Nielsen, G. (March 1990). **Bone strength of laying hens kept in an alternative system, compared with hens in cages and on deep-litter.** *British Poultry Science* 31(1):81-89.
NAL call number: 47.8 B77
Descriptors: housing, bone strength, cage, deep litter, welfare.

Norgaard-Nielsen, G., K. Vestergaard, and H.B. Simonsen (1993). **Effects of rearing experience and stimulus enrichment on feather damage in laying hens.** *Applied Animal Behaviour Science* 38(3-4):345-352.
NAL call number: QL750.A6
Descriptors: dustbath, substrate, plumage, hens, Hans Kier System, feather pecking.

Okamoto, S., S. Nagata, S. Kobayashi, and T. Matsuo (1989). **Effects of photoperiod and cage density on growth and feed conversion in large and small quail lines selected for body weight.** *Japanese Poultry Science* 26(3):150-156.
NAL call number: 47.8 N57
Descriptors: illumination, photoperiod, cage, density, quail.

O'Keefe, T.R., H.B. Graves, and H.S.Siegel (1986). **The effect of changing housing density on the social organization and agonistic behavior of the domestic fowl *Gallus domesticus*.** *Poultry Science* 65(Supplement 1):185.
NAL call number: 47.8 AM33P
Descriptors: dominance, stress, aggressive behavior, housing, density, social, agonistic, fowl.

Okpokho, N.A. and J.V. Craig (1987). **Fear-related behavior of hens in cages: Effects of rearing environment, age, and habituation**. *Poultry Science* 66(2):376-377.
NAL call number: 47.8 AM33P
Descriptors: tonic immobility, stress, floor pen, cage, hens, avoidance behavior.

Parrish, J.W. and D.K. Saunders (1989). **Simplified cage modification to reduce self-inflicted injury in confined birds**. *Wildlife Society Bulletin* 17(1):80-81.
NAL call number: SK357.A1W5
Descriptors: wildlife, field methods, wild birds, fiberglass screen.

Prayitno, D., C.J.C. Phillips, and H. Omed (1993). **The initial and long-term preference of broilers for red, blue, or green light after being reared in red, blue, green, or white light.** *Animal Production* 56(3):438.
NAL call number: 49 AN55
Descriptors: rearing environment, lighting, broilers, embryology.

Preston, A.P. (December 1987). **Location in the cage and diurnal distribution of feather pecking by caged layers.** *British Poultry Science* 28(4):653-658.
NAL call number: 47.8 B77
Descriptors: cage, motivation, hens, feather pecking, environmental stimulation, behavior.

Rajecki, D.W., S.J. Suomi, E.A. Scott, and B. Campbell (1977). **Effects of social isolation and social separation in domestic chicks.** *Developmental Psychology* 13(2):143-155.
NAL call number: BF712 P7
Descriptors: social behavior, group housing, isolation.

Ramos, N.C., K.E. Anderson, and A.W. Adams (November 1986). **Effects of type of cage partition, cage shape, and bird density on productivity and well-being of layers.** *Poultry Science* 65(11):2023-2028.
NAL call number: 47.8 AM33P
Descriptors: housing, cages, density, shape, size, partitions, production.

Ramos, N.C. and J.V. Craig (1985). **Social dominance and pre-laying behaviour of hens in 4-bird cages.** *Poultry Science* 64(Supplement 1):166.
NAL call number: 47.8 AM33P
Descriptors: aggression, genetics, production, social dominance, hen, pre-laying behavior.

Reed, H.J. and C.J. Nicol (1992). **Effects of nest linings, pecking strips and partitioning on nest use and behaviour in modified battery cages.** *British Poultry Science* 33(4):719-727.
NAL call number: 47.8 B77
Descriptors: housing, nest lining, cage partitions, nest disturbance, cage, behavior.

Reed, H.J., L.J. Wilkins, S.D. Austin, and N.G. Gregory (1993). **The effect of environmental enrichment during rearing on fear reactions and depopulation trauma in adult caged hens.** *Applied Animal Behaviour Science* 36(1):39-46.
NAL call number: QL750.A6
Descriptors: handling, fear, housing, injury, humans, hens.

Roush, W.B. and T.L. Cravener (September 1990). **Evaluation of colony size and cage space for laying hens (*Gallus domesticus*) using fuzzy decision analysis.** *Poultry Science* 69(9):1480-1484.
NAL call number: 47.8 AM33P
Descriptors: cage size, density, space, hens, egg production, mortality.

Rowley, I., E. Russell, and M. Palmer (1989). **The food preference of cockatoos: An aviary experiment.** *Australian Wildlife Research* 16(1):19-32.
NAL call number: S960 W5
Descriptors: seed preferences, seed size, Psittaciformes, cockatoo.

Savory, C.J., E. Seawright, and A. Watson (1992). **Stereotyped behaviour in broiler breeders in relation to husbandry and opioid receptor blockade.** *Applied Animal Behaviour Science* 32(4):349-360.
NAL call number: QL750.A6
Descriptors: feed restriction, stress, group housing, battery cage, cage, broilers, behavior.

Sherwin, C.M. (1995). **Environmental enrichment for laying hens: Spherical objects in the feed trough.** *Animal Welfare* 4(1): 41-51.
NAL call number: HV 4701 A557
Descriptors: foraging, feeding behavior, leather balls, rubber balls, tennis balls.

Sherwin, C.M. (ed) (1994) ***Modified cages for laying hens.*** Universities Federation for Animal Welfare: South Mimms, Potters Bar, Herts., UK, 102 p.
NAL call number: SF494.5 M63 1994
Descriptors: housing, caging, welfare.

Sherwin, C.M. (1993). **Pecking behaviour of laying hens provided with a simple motorized environmental enrichment device.** *British Poultry Science* 34(2):235-240.
NAL call number: 47.8 B77
Descriptors: motivation, choice, water provision, environmental control, behavior, hens, cage, peck.

Sherwin, C.M. (1992). **Design of cages for laying hens and the influences on behaviour and welfare.** *Journal of Animal Science* 70(Supplement 1):172.
NAL call number: 49 J82
Descriptors: feed trough, nest, feeding activity, hens, behavior, welfare, bar cage.

Sherwin, C.M. and C.J. Nicol (1993). **A descriptive account of the pre-laying behaviour of hens housed individually in modified cages with nests.** *Applied Animal Behaviour Science* 38:49-60.
NAL call number: QL750 A6
Descriptors: hen, pre-laying behavior, cage, nest, housing, welfare, egg-laying behavior.

Sherwin, C.M. and C.J. Nicol (1993). **Factors influencing floor-laying by hens in modified cages.** *Applied Animal Behaviour Science* 36(2-3):211-222.
NAL call number: QL750 A6
Descriptors: battery cage, litter-reared, nests, social interactions, cage, hens.

Sherwin, C.M. and C.J. Nicol (1992). **Behaviour and production of laying hens in three prototypes of cages incorporating nests.** *Applied Animal Behaviour Science* 35:41-54.
NAL call number: QL750 A6
Descriptors: hen, cage, nest, behavior, production, welfare.

Slaugh, B.T., N.P. Johnston, J.T. Flinders, and R.K. Bramwell (August 1990). **Effect of light regime on welfare and growth of pheasants.** *Animal Technology: Journal of the Institute of Animal Technology* 41(2):103-114.
NAL call number: QL55.I5
Descriptors: photoperiod, feed conversion, feathering, ring-necked pheasant.

Smith, C.P. (1992). ***Animal Models in Biomedical Research: Poultry***. *Special Reference Brief 92-17* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 80p.
NAL call number: aS21 D27S64
Descriptors: husbandry, bibliographies, biomedical research use.

Struwe, F.J., E.W. Gleaves, J.H. Douglas, and P.L. Bond, Jr. (January 1992). **Effect of rearing floor type and ten-day beak trimming on stress and performance of caged layers.** *Poultry Science* 71(1):70-75.
NAL call number: 47.8 AM33P
Descriptors: debeaking, litter floor, wire floor, pullet, corticosterone.

Sullivan, J.P., K.A. Grasman, and P.F. Scanlon (1992). **Effects of handling and pair management on reproduction in Japanese quail *Coturnix coturnix japonica*.** *Theriogenology* 37(4):877-883.
NAL call number: QP251.A1TS
Descriptors: pairing intervals, mating opportunity, intercage transport, egg number, quail, handling.

Tanaka, T. and J.F. Hurnik (February 1992). **Comparison of behavior and performance of laying hens housed in battery cages and an aviary.** *Poultry Science* 71(2):235-243.
NAL call number: 47.8 AM33P
Descriptors: battery cage, aviary, behavior, production, activity, environment.

Tanaka, T. and J.F. Hurnik (March 1991). **Behavioral responses of hens to simulated dawn and dusk periods**. *Poultry Science* 70(3):483-488.
NAL call number: 47.8 AM33P
Descriptors: sudden illumination, gradual illumination, comfort, battery cage, activity, behavior, hens.

Tanaka, T. and J.F. Hurnik (February1991). **Research note: The behavior of young layers during the first two weeks in aviary and battery cages**. *Poultry Science* 70(2):404-407.
NAL call number: 47.8 AM33P
Descriptors: housing density, feather-pecking, space, feeding, drinking, hens, behavior, cage.

Tauson, R. (1985). **Mortality in laying hens caused by differences in cage design.** *Acta Agriculturae Scandinavica* 35(2):165-174.
Descriptors: cage, engineering-related trauma, neck, head, toe, claw.

van Liere, D.W. (1992). The significance of fowls' bathing in dust. *Animal Welfare* 1:187-202.
NAL call number: HV470 A557
Descriptors: animal welfare, dustbath, feather, lipid, litter, sand, peat.

Vestergaard, K. (1992). **The development of feather pecking in the fowl: Its association with dustbathing**. *Journal of Animal Science* 70(Supplement 1):176.
NAL call number: 49 J82
Descriptors: behavior, poultry, enrichment, displacement, feather pecking, dustbathing.

Wathes, C.M., D.R. Charles, and J.A. Clark (1985). **Group size and plumage damage in laying hens**. *British Poultry Science* 26(4):459-464.
NAL call number: 47.8 B77
Descriptors: floor space, age, density, battery cage, hen, plumage, group.

Wegner, R-M. (1990). **Experience with the get-away cage system**. *World's Poultry Science Journal* 46(1):41-47.
NAL call number: 47.8 W89
Descriptors: hens, nest box, perch, behavior.

Wiepkema, P.R. (1985). **Abnormal behaviours in farm animals: Ethological implications**. *Netherlands Journal of Zoology* 35(1-2):279-299.
NAL call number: 410 AR27
Descriptors: animal awareness, feelings, environmental control, behavior, farm, ethological.

Wineland, M.J. (1987). **Nesting stimuli affects egg quality and numbers.** *Poultry Digest* 46(542):162-164.
NAL call number: 47.8 N219
Descriptors: color, illumination, breeding, management, nesting, egg.

Zocchi, D.C. and S.E. Brauth (1991). **An experimental study of mate directed behaviour in the budgerigar (*Melopsittacus undulatus*)**. *Bird Behaviour* 9(1-2):49-57.
Descriptors: budgerigar, social proximity, social cues, breeding, familiarity.

Cats

Enriching the Environment of the Laboratory Cat

Sandra McCune
Sub-Department of Animal Behaviour, University of Cambridge,
Madingley, Cambridge CB3 8AA, UK

Cats are intelligent, highly specialized carnivores. Like many predators, their senses are highly developed (reviewed by Bradshaw 1992). The cat's ability to hear, see and smell outside our own range give it a very different perception of its environment to ours. For example, it has a second olfactory system, the vomerosensory system which is associated with social behavior. The system is used when cats come into contact with other cats or their urine. In addition, the cat's visual images are supplemented with information from its highly developed sense of balance and sensory hairs on the head and legs which give the cat its position relative to other objects.

The domestic cat, *Felis silvestris catus,* used in laboratories is the same species that is commonly kept as a pet and exists in substantial numbers in feral colonies. Until recently, cats were thought to be essentially solitary but studies have shown they are also found in large socially structured groups (at densities of over 2000 per km^2 Izawa 1984; Izawa *et al.* 1982; Kerby and Macdonald 1988). The key to the success of the domestic cat is flexibility. Its ability to adapt enables it to survive in environments as diverse as the laboratory cage and isolated islands where individual territories can reach 6 km^2 (Liberg and Sandell 1988). The rest of this paper introduces the problems of confinement experienced by domestic cats, the principles of enrichment relevant to this species and the role of enrichment in preventing and relieving problems.

Specific problems associated with confinement include boredom, aggression to people and to cats, fearfulness, poor reproductive success, anorexia, tail-chasing, stereotypies, fabric eating and self-mutilation (Mellen 1988; Holmes 1993). It seems that cats confined in relatively restricted environments are more likely to develop behavior problems as Mertens and Schär (1988) claim pet cats restricted to indoors are more likely to be presented for behavior problems than cats with access to outdoors. As single laboratory caging represents the most extreme and barren environment in which cats are confined, it is likely that this is where the worst problems will develop. However, any form of cat housing can be made more stimulating, complex, and less predictable through both environmental and social enrichment.

Environmental enrichment

Above a critical minimum, improving *quality* of space for cats rather than *quantity* may be a better investment (Mansard 1989). In several species, increasing housing space alone did not change levels of activity (Hite *et al.* 1977; Bebak and Beck 1993). Quality of space can be improved by providing a range of resting places, by extending vertical space, by increasing complexity and by frequently changing internal structure and contents.

Elevated resting places are particularly favored by cats for watching their surroundings. They also preferred resting places that were warm, dry, and protected on one, or even better, two sides (Smith 1990; Roy 1992) and situated in the corners or edges of an enclosure where they can watch without the possibility of being approached from behind (Roy 1992). A range of resting places should be provided so that cats can choose their degree of contact with other cats. This may be particularly important if they are timid or the focus of aggression. The provision of shelves, ropes and climbing poles (illustrated in Loveridge 1984; Horrocks 1994) enrich the enclosure's vertical complexity and extend the available space. The latest advances in enriched group-housing are illustrated in Loveridge's paper (1994). Shelving allows the available space to be separated into functional areas. For example, the areas can be allocated to food, litter, scratch posts, toys, bedding and viewing points. These areas can be changed to promote activity. If shelves are hinged so they can fold down, the internal space periodically can be changed by erecting different combinations of the shelves available. Surface materials commonly used are metal and plastic but cats prefer materials which maintain a constant temperature such as straw, shredded paper, shavings, sacks, clothes or wood (Roy 1992).

Within the available space, furniture and objects can be provided to create a focus of interest, exploration and play. Toys which provide movement and which are frequently changed attract the most interest.

Food has been the focus of enrichment for several other *Felis* species (Mellen *et al.* 1981; Law *et al.* 1990). In laboratories, dry food is particularly suitable for hiding in the enclosure or for placing inside containers which the cat has to work at to extract individual pieces. A cheap version of a food puzzle can be made by gluing together two yoghurt containers containing dry food, with holes just large enough to extract one piece at a time. The puzzle can be made more challenging by hanging the tubs just above the cat's head height. Puzzle boxes for cats are now commercially available. Alternatives include hiding food inside cardboard boxes, in bedding, on shelves and inside rolling toys.

Social enrichment

The social environment can also improve the quality of time spent confined. Cats vary in their degree of sociability. In colonies where new cats frequently join the group, some cats remain essentially solitary (Roy 1992) whereas others form social attachments which undoubtedly enrich their lives by adding variety and complexity. By providing a variety of retreats and resting places, cats have the opportunity to interact closely with other cats or to remain alone if less sociable.

Social contact with cats

Singly caged cats lack the opportunity that communally confined cats have for rich, interactive relationships. Ideally, cats should remain in stable groups. If research requires single housing, cats can often be returned to social groups in between trials or for a period each day.

Social contact with people

People are also a rich source of stimulation. Many cats respond positively to human social contact. Cats kept in a relatively restricted environment will seek additional stimulation from people (Turner and Stammbach-Geering 1990) indicating they may derive some benefit from the contact.

If direct contact is not possible, social enrichment can be indirect. Visual, vocal and olfactory communication are possible without direct contact by the use of glass partitions and grills between pens. Access to a communal room in which other cats have previously left chemical messages, rubbed from their glands, or sprayed in their urine, convey information to cats about each other (Natioli 1984). Providing scratch posts enables cats to keep their claws trimmed but also allows them to leave olfactory and visual messages (scratch marks) to other cats in the colony. The sound of voices on radio may habituate timid cats to people (Hurni and Rossbach 1987).

Many problems associated with confinement can be prevented by adequate early socialization and careful selection of cats for suitable temperament (McCune in press; Reisner 1994; McCune *et al.* 1995). One study showed that friendly, confident cats were less distressed by being caged, their normal behavior was less inhibited and they adapted sooner than timid cats (McCune 1992). For cats inadequately socialized as kittens and already stressed by caging, social contact can be an additional stressor. For these individuals, methods other than handling must be used to relieve stress and enrich the captive environment (McCune 1995). Individuals will vary in both their need for enrichment and the benefit it provides them. For example, cats with a timid temperament (McCune 1992), extremes of age (McCune 1994) and restricted experience (Konrad and Bagshaw 1970; Ledger 1993) are more likely to have problems adjusting to

confinement and responding to novelty. Mellen (1988) claims that male cats are more likely than female cats to develop problems in restricted environments.

Few of these studies were primarily interested in environmental enrichment. Techniques of enrichment need to be scientifically validated to promote and communicate methods that work for cats and to avoid techniques which produce problems. Assessments should look for a decrease in abnormal behavior and a behavioral repertoire which more closely resembles that of free-ranging cats (UK Cat Behavior Working Group 1995). Research animals without behavior problems are likely to have better welfare and produce better quality data.

References

Bebak, B., and A.M. Beck (1993). **The effect of cage size on play and aggression between dogs in purpose-bred Beagles.** *Laboratory Animal Science* 43:457-459.

Bradshaw, J.W.S. (1992). ***The Behaviour of the Domestic Cat*** CAB International: Wallingford.

Carlstead,K., J.L Brown, and J. Seidensticker (1993). **Behavioural and adrenocortical responses to environmental changes in Leopard Cats *(Felis bengalensis)*.** *Zoo Biology* 12:321-331.

Carlstead K, J.L. Brown, S.L. Monfort, R. Killens and D.E.Wildt (1992). **Urinary monitoring of adrenal responses to psychological stressors in domestic and nondomestic felids.** *Zoo Biology* 11: 165-176.

Hite M., H.M. Hanson, N.R. Bohidar, P.A. Conti, and P.A. Mattis (1977). **Effect of cage size on patterns of activity and health of Beagle dogs.** *Laboratory Animal Science 27:* 60-64.

Holmes, R. (1993). **Environmental enrichment for confined dogs and cats.** In: *The TJ Hungerford Refresher Course for Veterinarians Proceedings 214,* The Post Graduate Committee in Veterinary Science: University of Sydney, pp. 191-197.

Horrocks, L. (1994). **Care and management of WALTHAM pets**. *Waltham Focus* 4:11-16.

Hurni, H. and W. Rossbach (1987). **The laboratory cat.** In: *The UFAW Handbook on the Care and Management of Laboratory Animals, 6th edition* T.B. Poole, ed. Longman Scientific and Technical: Harlow, pp. 476-492.

Izawa, M. (1984). ***Ecology and social systems of the feral cats (Felis catus Linn.).*** Ph.D. thesis: Kuyshu University.

Izawa, M., T. Doi and Y. Ono (1982). **Grouping patterns of feral cats (Felis catus) living on a small island in Japan.** *Japanese Journal of Ecology 32:373-382.*

Kerby, G. and D.W. Macdonald (1988). **Cat society and the consequences of colony size.** In: *The Domestic Cat: The Biology of its Behavior* D.C. Turner and P. Bateson, eds., Cambridge University Press: Cambridge, pp. 67-81.

Konrad, K.W. and M. Bagshaw (1970). **Effect of novel stimuli on cats reared in a restricted environment.** *Journal of Comparative and Physiological Psychology 70:157-164.*

Law, G., H. Boyle, J. Johnston and A. Macdonald (1990). **Food presentation: Part 2-Cats.** *RATEL* 17:103-105.

Ledger, R. (1993). ***Factors Influencing the Responses of Kittens to Humans and Novel Objects*** MSc thesis: University of Edinburgh.

Liberg, 0. and M. Sandell (1988). **Spatial organization and reproductive tactics in the domestic cat and other felids.** In: *The Domestic Cat: The Biology of its Behavior* D.C. Turner and P. Bateson, eds., Cambridge University Press: Cambridge, pp. 83-98.

Loveridge, G. (August 1994). **Provision of environmentally enriched housing for cats.** *Animal Technology: Journal of the Institute of Animal Technology* 45(2):69-87.

Loveridge, G. (1984). **The establishment of a barriered respiratory disease-free cat breeding colony.** *Animal Technology: Journal of the Institute of Animal Technology* 35:83-92.

Mansard, P. (1989). **Some environmental considerations for small cats.** *RATEL* 16:-12-15.

McCune, S. (in press) **The impact of paternity and early socialization on the development of cats' behaviour to people and novel objects.** *Applied Animal Behaviour Science.*

McCune, S. (1995). **Coping with confinement: Temperament effects on how domestic cats adjust to caging and handlers.** In: *Environmental Enrichment for Captive Animals* Shepherdson D., Mellen J. and Hutchins M.eds., Smithsonian Institution Press: Washington DC.

McCune, S. (1994). **Caged cats: Avoiding problems and providing solutions.** *Newsletter of the Companion Animal Behaviour Study Group No. 7.*

McCune, S. (1992). ***Temperament and the Welfare of Caged Cats*** Ph.D. thesis: University of Cambridge.

McCune, S., J.A. McPherson, and J.W.S. Bradshaw (1995). **Avoiding problems: The importance of socialization.** In: *The Waltham Book of Human-Animal Interactions* I. Robinson, ed., Pergamon Press: Oxford.

Mellen, J.D. (1988). **The effects of hand-raising on sexual behaviour of captive small felids using domestic cats as a model.** *AAZPA Annual Proceedings*: 253-259.

Mellen, J.D., V.J. Stevens and H. Markowitz (1981). **Environmental enrichment for servals, Indian elephants and Canadian otters at Washington Park Zoo, Portland.** *International Zoo Yearbook.* 21:196-201.

Mertens, C. and Schär, R. (1988) **Practical aspects of research on cats.** In: *The Domestic Cat: The Biology of its Behavior* D.C. Turner and P. Bateson, eds., Cambridge University Press: Cambridge, pp. 179-190.

Natioli, E. (1985). **Behavioural responses of urban feral cats to different types of urine marks.** *Behaviour* 94: 234-243.

Podberscek, A.L., J.K. Blackshaw and A.W. Beattie (1991). **The behaviour of laboratory colony cats and their reactions to a familiar and unfamiliar person.** *Applied Animal Behaviour Science* 31:119-130.

Reisner, I.R., K.A. Houpt, N.E. Hollis and F.W. Quimby (1994). **Friendliness to humans and defensive aggression in cats: The influence of handling and paternity.** *Physiology and Behaviour* 55:1119-1124.

Roy, D. (1992). ***Environmental Enrichment for Cats in Rescue Centres*** B.Sc. thesis: University of Southampton.

Smith, D. (1990). ***Sociality and Behaviour in Rescued Cats*** B.Sc. thesis: University of Southampton.

Turner, D.C. and K. Stammbach-Geering (1990). **Owner assessment and the ethology of human-cat relationships.** In: *Pets, Benefits and Practice* I.H. Burger, ed., British Veterinary Association Publications: London.

UK Cat Behaviour Working Group (1995). ***An Ethogram for Behavioural Studies of the Domestic Cat (Felis silvestris catus L.)*** Universities Federation for Animal Welfare: Potters Bar, England, 31pp.

Cat Bibliography

Animal Welfare Institute (1979). **Cats**. In: *Comfortable Quarters for Laboratory Animals*. Animal Welfare Institute: Washington, D.C., pp. 44-51.
NAL call number: SF91.A5 1979
Descriptors: resting boards, social housing, scratching post, tree trunks.

Bateson, P., M. Mendl and J. Feaver (1990). **Play in the domestic cat is enhanced by rationing of mother during lactation**. *Animal Behaviour* 40:514-525.
NAL call number: 410 B77
Descriptors: colony cats, object play, social play, restricted versus ad libitum maternal feeding.

Beaver, B. (1980). ***Veterinary Aspects of Feline Behavior*** C.V. Mosby Co.: St. Louis, Missouri, 217p.
NAL call number: SF446.5.B4
Descriptors: senses, play, learning, communicative behavior, socialization, hunting.

Behrend, K. and M.Wegler (1991). ***Complete Book of Cat Care: How to Raise a Happy and Healthy Cat*** Barron's Educational Series, Inc.: Hauppauge, NY., 141p.
NAL call number: SF447.B4513 1993
Descriptors: toys, scratching posts, exercise, play, hunting, color photos.

Blackshaw, J.K. (December 1988). **Abnormal behavior in cats.** *Australian Veterinary Journal* 65(12):395-396.
NAL call number: 41.8 Au72
Descriptors: animal behavior, cats, aggression, grief, social behavior.

Bradshaw, J.W.S. (1992). ***The Behavior of the Domestic Cat*** Redwood Press Ltd: Melksham, UK., 219p.
NAL call number: SF446.5.B72 1992
Descriptors: sensory abilities, behavioral development, hunting, predation, social behavior, cat-human relationship, welfare.

Carlstead, K., J.L. Brown and W. Strawn (1993). **Behavioral and physiological correlates of stress in laboratory cats.** *Applied Animal Behaviour Science* 38:143-158.
NAL call number: QL750 A6
Descriptors: ACTH, cortisol, caged cats, caretaking routine, hiding behavior, reproductive hormones.

Caro, T.M. (1981). **Predatory behaviour and social play in kittens.** *Behaviour* 76(1-2):1-24.
NAL call number: 410 B393
Descriptors: ontogeny, play, relationships.

DeLuca, A.M. and K.C. Kranda (January 1992). **Environmental enrichment in a large animal facility.** *Lab Animal* 21(1):38-44.
NAL call number: QL55.A1L33
Descriptors: dogs, cats, swine, gumadisc, nylabone frisbee, plastic chain, decoys, gumabone tug, catnip, sheepskin mice, balls, bells, cotton tugs, scented apples.

Dore, F.Y. (September 1990). **Search behavior of cats (*Felis catus*) in an invisible displacement test: Cognition and experience.** *Canadian Journal of Psychology* 44(3):359-70.
Descriptors: attention, cats, psychology, orientation, predatory behavior, problem solving, object permanence, psychomotor performance, recall, prior experience.

Drouard, C.M. (1979). ***Behavior of housed and stray cats.* [*Le comportement du chat et les chats errants*.]** Thesis, Ecole Nationale Veterinaire: Alfort, France, 140pp.
Descriptors: cat diseases animal welfare; cat, animal behavior.

Fox, M.W. (1975). **The behavior of cats.** In: *The Behavior of Domestic Animals*, E.S.E. Hafez, ed., 3rd edition, Bailliere Tindall: London, UK. pp. 410-436.
NAL call number: QL785.5.D7H3 1975
Descriptors: behavior, mating, cat, kitten, play, hunting, development, early experience, learning.

Frazier, A. and N. Eckroate. (1990). **Desirable behavior in cats and owners.** In: *The New Natural Cat: A Complete Guide for Finicky Owners*. Penguin Books: New York, NY, 448p.
NAL call number: SF447.F7 1990
Descriptors: scratching posts, toys, unsafe toys, games, play, exercise.

Guyot, G.W., T.L. Bennett, and H.A. Cross. (May 1980). **The effects of social isolation on the behavior of juvenile domestic cats.** *Developmental Psychobiology* 13(3):317-329.
NAL call number: QP351 D4
Descriptors: early experience, social environment, mother-offspring interactions, play, exploratory behaviour.

Hart, B.L. (1978). ***Feline Behavior: Collected Columns from Feline Practice Journal.*** Veterinary Practice Publishing Company: Santa Barbara, CA., 110p.
NAL call number: SF446.5.H37
Descriptors: sexual behavior, senses, development, sleep, grooming, predatory behavior, behavior modification.

Hart, B.L. (1974). **Feline behavior: The role of grooming activity.** *Feline Practice* 6(4):14,16.
NAL call number: SF985.F4
Descriptors: saliva, skin, hair, behavior, cat.

Hart, B.L. (1974). **Feline behavior: Predatory behavior.** *Feline Practice* 4(2):8-9.
NAL call number: SF985.F4
Descriptors: cat, hunting, prey.

Hart, B.L. (1974). **Feline behavior: The catnip response.** *Feline Practice* 4(6):8,12.
NAL call number: SF985.F4
Descriptors: *Nepeta cataria*, behavior, cat.

Hart, B.L. (1980). **Feline behavior: The cat as hunter.** *Feline Practice* 10 (5):8, 10-11
NAL call number: SF985.F4
Descriptors: predatory behavior.

Hatch, R.C. (1972). **Effect of drugs on catnip (*Nepeta cataria*):Induced pleasure behavior in cats.** *American Journal of Veterinary Research* 33(1):143-155.
NAL call number: 41.8 Am3A
Descriptors: drugs, cat, behavior.

Hayes, A.A. (1985). **Keeping your cat healthy: Play/Exercise.** In: *The Complete Book of Cat Health* W.J. Kay and E. Randolph, eds., Macmillan Publishing Company: New York, NY, pp. 52-53.
NAL call number: SF447.K39
Descriptors: jump, climb, indoor tree, tunnel, scratching device, perch, safety.

Karsh, E.B. (1983). **The effects of early handling on the development of social bonds between cats and people.** In: *New Perspectives on Our Lives with Companion Animals*, A.H. Katcher and A.M. Beck, eds., University of Pennsylvania Press: Philadelphia, PA, pp. 22-28.
NAL call number: SF411.5.N48
Descriptors: research colony vs. pet cats, behavior differences, early experience, preference.

Karsh, E. (1984). **Factors influencing the socialization of cats to people.** In: *The Pet Connection: Its Influence on Our Health and Quality of Life*. R.K. Anderson, B.L. Hart, and L.A. Hart, eds., University of Minnesota: Minneapolis, Minn., pp. 207-215.
NAL call number: SF411.5.P47
Descriptors: social bonds, handling, critical period, friendly responses to humans.

Kubota, K. (September 1987). **Physiology of the brain: Intelligent behavior and brain.** *Nippon Rinsho* 45(9):1998-2009.
Descriptors: behavior, animal behavior, cerebral cortex, intelligence, cats, haplorhini, memory, visual cortex, visual perception.

Kupper, W. (1979). **Keeping laboratory cats under the right conditions. [Zur artgemassen und verhaltensgerechten Unterbringung von Versuchskatzen.]** *Du und das Tier* 9(1):32-33.
Descriptors: laboratory animal house, animal welfare, cage, technical personnel, laboratory animals, cat.

Kristensen, F. and J.A. Barsanti (1977). **Analysis of serum proteins in clinically normal pet and colony cats, using agarose electrophoresis.** *American Journal of Veterinary Research* 38(3):399-402.
NAL call number: 41.8 Am3A
Descriptors: hematology, laboratory animals, blood proteins, cat, increased gamma-globulins in colony cats vs. pet cats.

Leyhausen, P. (1979). ***Cat Behavior: The Predatory and Social Behavior of Domestic and Wild Cats.*** Garland STPM Press: New York, 340p.
NAL call number: QL737.C23L49
Descriptors: social behavior, aggression, behavior towards prey, play, experience, learning.

Loveridge, G., Horrocks, L.J, and A.J. Hawthorne (May 1995). **Environmentally enriched housing for cats when housed singly.** *Animal Welfare* 4(2):135-141.
NAL call number: HV4701.A557
Descriptors: human-animal contact, single housing, glass walls, sensory stimulation, socialization.

Loveridge, G. (August 1994). **Provision of environmentally enriched housing for cats.** *Animal Technology: Journal of the Institute of Animal Technology* 45(2):69-87.
NAL call number: QL55.I5
Descriptors: cats, animal housing, environment enrichment, design, animal husbandry, socialization, animal welfare.

Luesher, U.A., D.B. McKeown and J. Halip. (March 1991). **Stereotypic or obsessive-compulsive disorders in dogs and cats.** *Veterinary Clinics of North America: Small Animal Practice* 21(2):401-413.
NAL call number: SF601 V523
Descriptors: grooming, polydipsia, circling, whirling, barking, aggression, early experience, conflict behavior.

Martin, P. and P. Bateson. (1985). **The ontogeny of locomotor play behavior in the domestic cat.** *Animal Behaviour* 33:502-510.
NAL call number: 410 B77
Descriptors: laboratory conditions, indoor pen, climbing frame, kittens, locomotor behavior, vocalizations.

Martin, P. (1985). **The influence of experimentally manipulating a component of weaning on the development of play in domestic cats.** *Animal Behaviour* 33(2):511-518.
NAL call number: 410 B77
Descriptors: kittens, weaning, social play, object play, locomotor play.

Martin, P. (1984). **The time and energy cost of play behavior in the cat.** *Zeitscrift für Tierpsychologie* 64:298-312.
NAL call number: 410.Z35
Descriptors: *Felis catus*, colony cats, kittens, percentage of total time spent playing, toys, metabolic rate.

Mellen, J.D. (1992). **Effects of early rearing experience on subsequent adult sexual behavior.** *Zoo Biology* 11(1):17-32.
NAL call number: QL77.5 Z6
Descriptors: human rearing, maternal rearing, aggression.

Mertens, C. and D.C. Turner (Fall 1988). **Experimental analysis of human-cat interactions during first encounters.** *Anthrozoos* 2(2):83-97.
NAL call number: SF411.A57
Descriptors: colony cats, contact latency, play, vocalizations, head rubbing.

Moelk, M. (1979). **The development of friendly approach behavior in the cat: A study of kitten-mother relation and the cognitive development of the kitten from birth to eight weeks.** *Advances in the Study of Behavior* 10:163-224.
NAL call number: QL750 A33
Descriptors: approach behavior, ontogeny, cognition.

Poucet, B. (May 1985). **Spatial behavior of cats in cue-controlled environments.** *Quarterly Journal of Experimental Psychology* 37(2):155-79.
Descriptors: cues, discrimination learning, orientation, space perception, cats.

Reichart, E. (1984). **The importance of behavioral interactions of the laboratory cat and man.** *Stal Sciences et Techniques de l'Animal de Laboratoire.* 9(3):149-156.
Descriptors: handler, experimenter, human-animal interaction.

Shepherdson, D.J., K. Carlstead, J.D. Mellen and J. Seidensticker. (1993). **The influence of food presentation on the behavior of small cats in confined environments.** *Zoo Biology* 12:203-216.
NAL call number: QL77.5 Z6
Descriptors: *Felis viverrina*, *Felis bengalensis*, exhibit animals, activity budget, live prey, environmental enrichment.

Smith, C.P. (1994). ***The Cat: January 1984 - January 1994.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 73p.
NAL call number: aZ5071.N3 no. 94-25
Descriptors: bibliography, behavior, stress, housing, nutrition.

Stasiak, M. and B. Zernicki (February 1993). **Delayed response learning to auditory stimuli is impaired in cage-reared cats.** *Behavioral Brain Research* 53(1-2):151-154.
Descriptors: acoustic stimulation, housing, learning, cats, food, reward, sensory deprivation, vision.

Tellington-Jones, L. (1992). ***The Tellington Touch for Happier, Healthier Cats.*** Hartworks Video: Ashland, OR, VHS, 60 minutes.
NAL call number: Videocassette no. 1967
Descriptors: relaxation, training, behavior, body awareness.

Thierry, B. (1982). **Social requirements of the dog and cat as laboratory animals. [Les exigences sociales du chien et du chat en tant qu'animaux de laboratoire.]** *Sciences et Techniques de l'Animal de Laboratoire* 7(3):175-180
Descriptors: animal welfare, social behavior, laboratory animals

Turner, D.C. (1991). **The ethology of the human-cat relationship**. *Schweizer Archiv für Tierheilkunde* 133(2):63-70.
NAL call number: 41.8 SCH9
Descriptors: human-pet bonding, cats, behavior, housing.

Turner, D.C. and P. Bateson (1988). **The domestic cat: The biology of its behaviour.** In: *Symposium Cats 86*, D.C. Turner and P. Bateson, eds., Zurich-Irchel, Switzerland, September 1-3, 1986, Cambridge University Press: Port Chester, New York, USA; Cambridge, England, UK., pp. 9-22.
Descriptors: social development, senses, physiology.

Voith, V.L. (1980). **Clinical animal behavior play: A form of hyperactivity and aggression.** *Modern Veterinary Practice* 61(7):631-632.
NAL call number: 41.8 N812
Descriptors: cat, dog, kitten, pets, puppy, young animals, animal behavior, vices, aggression.

Wikmark, G., and J.M. Warren (March 1972). **Delayed response learning by cage-reared normal and prefrontal cats.** *Psychonomic Science* 26(5):243-245.
Descriptors: alley cats vs. cage-reared, lesions, cerebral cortex, cat learning, time, animal environments.

Dogs

Dogs and Dog Housing

Robert Hubrecht
Universities Federation for Animal Welfare
8 Hamilton Close, South Mimms
Potters Bar, Hertfordshire EN6 3QD, UK

Brief background

The dog is descended from the wolf, possibly the Southern wolf *(Canis lupus pallipes)*. Wolves are social carnivores that can combine into packs, and this trait is still shown by some feral dogs (Feddersen-Petersen 1994). Thousands of years of domestication and artificial selection have produced breeds, with modified social repertoires (Bradshaw and Brown 1990), that are capable of transferring conspecific social behavior to humans. Like most larger mammals, dogs spend a considerable portion of their time inactive (Hubrecht *et al.* 1992, Adams and Johnson 1993). However, as a diet opportunist, the dog is adapted to seeking a wide variety of foods in unpredictable locations, it is therefore much more likely to be tolerant of novel items and circumstances than a more specialized feeder. Conversely, during its active periods it may be more easily bored by a predictable and limiting environment.

Physical needs

There are many publications that provide recommendations for the dog's general husbandry (e.g., MacArthur 1987, HMSO 1989, 1995). These are based on experience and provide valuable information but there has been very little research into specific physical requirements apart from diet. In most scientific work a tightly controlled environment is required to reduce unwanted variation, however, the dog is a very adaptable animal and a healthy adult can cope with a range of conditions, particularly if it has access to areas with different micro-climates.

Temperature, humidity, ventilation and lighting

An indoor temperature range of 15-24°C, and humidity of 55 percent ±10 percent, with 8-12 air changes per hour is suitable. New-born puppies require an ambient temperature of 26-28°C for at least the first 10 days of life. Lighting should be adequate for staff to work, and there may be a case for a low level of nocturnal illumination in totally enclosed facilities.

Diet

Dogs appear to prefer meat to cereal diets (Houpt and Smith 1981). Some breeds have a propensity for obesity (Anderson 1973), however, they will usually adapt well to the many proprietary diets available. Advice, if needed, should be sought from the suppliers.

Noise

Dog housing is often very noisy because of barking, and sound pressures of well over 100 decibels have been recorded (Senn and Lewin 1975). Ottewill (1968) provided recommendations to reduce noise, mainly with the aim of improving conditions for the humans. The dog has a hearing frequency range of up to 55 kHz (Gamble 1982) with the most sensitive frequencies at 500Hz -16kHz. At these frequencies their hearing can be up to four times as acute as that of humans. Prolonged exposure to sound pressures of over 90 decibels is known to damage human hearing, and many sites advise or require hearing protection for the staff. It is not unreasonable to assume that such levels might also damage dog hearing, although there is very little evidence on this subject.

Social needs

It has been known for a long time that inadequate housing can lead to behavioral problems in dogs (Fuller 1967, Solarz 1970). Normal husbandry for the dog should allow plenty of opportunities for social interactions with humans (Wolfle 1992) and conspecifics (Fox 1986). Group housing of compatible dogs in pairs or larger groups is the preferred housing method, (HMSO 1989, Hubrecht *et al.* 1992, Hubrecht 1993b) but care is needed to control any fighting. Regular human contact during the puppies' socialization period (3-14 weeks) is particularly important to produce dogs that are relaxed with humans (Scott and Fuller 1965).

Environmental enrichment

Many laboratory enclosures are simple structures, with little or no complexity provided by cage furniture or subdivisions, and in some countries it is still legal and common practice to house dogs in what would seem to be very small cages. It is unlikely that such small enclosures can provide for the dogs' psychological needs (Hetts 1991). A good housing system should allow the dog to exercise an element of choice, to manipulate or chew safe objects, and provide opportunities for human and canine socialization (Hubrecht 1993a). Dogs sometimes have to be housed singly for experimental or quarantine reasons, in which case greater thought should be given to providing extra human contact time and an interesting environment.

Dog pens should be subdivided into separate sleeping and exercise areas which provide complexity, choice and allows the dog to defecate/urinate away from its sleeping area (Fox 1986). Solid partitions between pens provide privacy and help to prevent injuries, but can isolate the dog from its surroundings. A good pen design should allow the occupants to satisfy their natural curiosity about what is happening outside the enclosure. One solution is to provide platforms at a height that allows the dog to see over the partitions whilst lying down (Hubrecht 1993a). Such devices have the additional advantage of increasing the useable space available to dogs.

There have been a number of studies on the effects of exercise, and pen size (e.g., Campbell *et al.* 1988, Hughes *et al.* 1989, Bebak and Beck 1993, Hetts *et al.* 1992). There is no evidence that providing extra exercise *per se* improves welfare (Clark *et al.* 1991), although walks outside the enclosure are undoubtedly enjoyed.

Olfaction is an important canid sense. We know little about how to enrich an environment through odors but Hubrecht *et al.* (1992) found that dogs housed in groups spend more of their time sniffing and investigating the floor of their enclosure. Dogs will also make extensive use of chews, particularly if they taste of food and are presented properly (DeLuca and Kranda 1992, Hubrecht 1993a).

Breed differences and husbandry requirements should be kept in mind when considering enrichment options. It is also important to remember that dogs vary in temperament (Cattell and Korth 1973) and perhaps also in their housing requirements and ability to cope with a particular kennelling system.

References

Adams, G. J. and K.G. Johnson (1993). **Sleep wake cycles and other night-time behaviours of the domestic dog *Canis familiaris*.** *Applied Animal Behaviour Science 36:* 233-248.

Anderson, R.S. (1973). **Obesity in the dog and cat.** *Veterinary Annals* 14:182-186.

Bebak, J. and A. M. Beck (1993). **The effect of cage size on play and aggression between dogs in purpose-bred beagles.** *Laboratory Animal Science* 43:457-459.

Bradshaw, J.W.S. and S. Brown (1990). **Behavioural adaptations of dogs to domestication.** *Waltham Symposium* 20:18-24.

Campbell, S.A., H.C. Hughes, H.E. Griffin, M.S. Landi and F.M. Mallon (1988). **Some effects of limited exercise on purpose-bred Beagles.** *American Journal of Veterinary Research* 49:1298-1301.

Cattell, R.B. and B. Korth (1973). **The isolation of temperament dimensions in dogs.** *Behavioral Biology* 9:15-30.

Clark, J.D., J.P. Calpin and R.B. Armstrong (1991). **Influence of type of enclosure on exercise fitness of dogs.** *American Journal of Veterinary Research* 52:1024-1028.

DeLuca, A.M. and K.C. Kranda (1992). **Environmental enrichment in a large animal facility.** *Lab Animal* 21:38-44.

Feddersen-Petersen, D. (1994). **Comparative studies of behavioural development of wolves (*Canis lupus l*) and domestic dogs (*Canis lupus f fam*) - domestication traits and selective breeding.** *Tierärztliche Umschau* 49:527-531.

Fox, M.W. (1986). ***Laboratory Animal Husbandry: Ethology, Welfare and Experimental Variables.*** State University of New York Press: Albany, NY.

Fuller, J.L. (1967). **Experiential deprivation and later behaviour.** *Science* 158:1645-1652.

Gamble, M.R. (1982). **Sound and its significance for laboratory animals.** *Bio. Rev. 57*: 395-421.

Hetts, S. (1991). **Psychologic well-being: conceptual issues, behavioral measures and implications for dogs.** *Veterinary Clinics of North America Small Animal Practice* 21:369-87.

Hetts, S., J.D. Clark, J.P. Calpin, C.E. Arnold and J.M. Mateo (1992). **Influence of housing conditions on beagle behaviour.** *Applied Animal Behaviour Science* 34:137-155.

HMSO (1989). ***Code of Practice for the Housing and Care of Animals Used in Scientific Procedures.*** HMSO: London.

HMSO (1995). ***Code of Practice for the Housing and Care of Animals in Designated Breeding and Supplying Establishments.*** HMSO: London.

Houpt K.A. and Smith S.L. (1981). **Taste preferences and their relation to obesity in dogs and cats.** *Canadian Veterinary Journal 22*: 77-81.

Hubrecht, R.C. (1993a). **A comparison of social and environmental enrichment methods for laboratory housed dogs.** *Applied Animal Behaviour Science* 37: 345-361.

Hubrecht, R.C. (1993). ***Dog Housing and Welfare*** UFAW Animal Research Report No 6, Universities Federation for Animal Welfare (UFAW): Potters Bar, Herts, UK, 13p.

Hubrecht, R.C., J.A. Serpell and T.B. Poole (1992). **Correlates of pen size and housing conditions on the behaviour of kennelled dogs.** *Applied Animal Behaviour Science* 34:365-383.

Hughes, H.C., S. Campbell and C. Kenney (1989). **The effects of cage size and pair housing on exercise of beagle dogs.** *Laboratory Animal Science* 39:302-305.

MacArthur, J.A. (1987). **The Dog.** In: *The UFAW Handbook on the Care and Management of Laboratory Animals: 6th ed.*, T. Poole, ed., Longman Group: Harlow, England, pp. 456-475.

Ottewill, D. (1968). **Planning and design of accommodation for experimental dogs and cats.** *Laboratory Animal Symposium* 1:97-112.

Scott, J.P. and J.L. Fuller (1965). ***Genetics and the Social Behaviour of the Dog.*** University of Chicago Press: Chicago, Illinois.

Senn, C.L. and J.D. Lewin (1975). **Barking dogs as an environmental problem.** *Journal of the American Veterinary Medical Association* 166:1065-1068.

Solarz, A.K . (1970). **Behavior.** In: *The Beagle as an Experimental Dog.* A.C. Andersen, and L.S. Good, eds., Iowa State University Press: Ames, Iowa, USA, pp. 453-468.

Wolfle, T.L. (1992) **Socialization of dogs.** In: *Implementation Strategies for Research Animal Well-being: Institutional Compliance with Regulations*, L. Krulisch, ed., Conference Proceedings, SCAW: Bethesda, MD, pp. 15-21.

DOG BIBLIOGRAPHY

Agrawal, H.C., M.W. Fox, and W.A. Himwich (1967). **Neurochemical and behavioral effects of isolation rearing in dogs.** *Life Sciences* 6:71-78 (1967).
NAL call number: 442.8 L62
Descriptors: social interaction, environment, electrophysiology, electroencephalography, chemical analysis.

Althaus, T. (1989). **The evaluation of dog raising conditions. [Die beurteilung von hundehaltungen.]** *Schweizer Archiv für Tierheilkunde* 131(7):423-431.
NAL call number: 41.8 SCH9
Descriptors: animal husbandry, animal welfare, dogs, housing.

Anderson, A.C. and M. Goldman (1960). **An evaluation of an outdoor kennel for dogs.** *Journal of the American Veterinary Medical Association* 137:129-135.
NAL call number: 41.8 AM3
Descriptors: housing, economics, design, welfare.

Animal Welfare Institute (1979). **Dogs**. In: *Comfortable Quarters for Laboratory Animals.* Animal Welfare Institute: Washington, D.C., pp. 52-57.
NAL call number: SF91.A5 1979
Descriptors: resting boards, social housing, human interaction, bedding.

Bebak, J. and A.M. Beck (1993). **The effect of cage size on play and aggression between dogs in purpose-bred beagles.** *Laboratory Animal Science* 43(5):457-459.
NAL call number: 410.9 P94
Descriptors: welfare, exercise, cage size, cage design.

Besch, E.L. (1990). **Environmental variables and animal care.** In: *Canine Research Environment* J.A. Mench and L.Krulisch, eds., Scientists Center for Animal Welfare: Greenbelt, MD, pp. 53-57.
NAL call number: QL737.C22C36
Descriptors: dogs, animal housing, environment, laboratory animals.

Borchelt, P.L. and V.L. Voith (1982). **Diagnosis and treatment of separation-related behavior problems in dogs.** *Veterinary Clinics of North America: Small Animal Practice* 12(4):625-635.
NAL call number: SF601 V523
Descriptors: separation, behavior, animal care.

Bradshaw, J.W. and S.M. Wickens (April 1992). **Social behaviour of the domestic dog.** *Tijdschrift voor Diergeneeskude* 117(Supplement 1):50S-51S
NAL call number: SF601 N4
Descriptors: feral, dingo, bonding, social behavior.

Breazile, J.E. (1987). **Physiologic basis and consequences of distress in animals.** *Journal of the American Veterinary Medical Association* 191:1212-1215.
NAL call number: 41.8 AM3
Descriptors: stress, eustress, feeding behavior, reproduction, ACTH, glucocorticoids, sympathetic nervous system, responses.

Britz, W.E. Jr. (1990). **Caging systems for dogs under the new standards of the animal welfare act.** In: *Canine Research Environment* J.A. Mench and L. Krulisch, eds., Scientists Center for Animal Welfare:Greenbelt, MD, pp. 48-52.
NAL call number: QL737.C22C36
Descriptors: dogs, cages, animal welfare, legislation.

Campbell, S.A., H.C. Hughes, H.E. Griffin, M.S. Landi, and F.M. Mallon (August 1988). **Some effects of limited exercise on purpose-bred Beagles.** *American Journal of Veterinary Research* 49(8):1298-1301.
NAL call number: 41.8 AM3A
Descriptors: dogs, exercise, stress, lymphocyte transformation, cortisol, animal welfare.

Canadian Council on Animal Care (1993). **Social and behavioral requirements of experimental animals.** In: *Guide to the Care and Use of Experimental Animals*, E.D. Olfert, B.M. Cross and A.A. McWilliam, eds., Vol. 1, 2nd Edition, pp. 51-90.
NAL call number: SF406 G85 1993
Descriptors: welfare, well-being, environmental enrichment, social behavior, dogs, cats, rodents, rabbits, primates.

Carroll, T., D.A. Valerio, and G. Pucak (January 1990). **Socialization and management of purpose-bred dogs.** In: *Canine Research Environment* J.A. Mench and L. Krulisch, eds., Scientists Center for Animal Welfare: Greenbelt, MD, p. 37.
NAL call number: QL737.C22C36
Descriptors: dogs, animal husbandry, animal housing, animal breeding, animal welfare, socialization.

Case, D.B. (October 1985). **Puppy socialization.** *Veterinary Technician* 6(9):456-457.
NAL call number: SF406.A5
Descriptors: dogs, pups, social behavior, deviant behavior, behavior modification, animal housing.

Clark, J.D., J.P. Calpin, and R.B. Armstrong (July 1991). **Influence of type of enclosure on exercise fitness of dogs.** *American Journal of Veterinary Research* 52(7):1024-1028.
NAL call number: 41.8 AM3A
Descriptors: animal welfare, animals, dogs, housing, physical fitness, hydrocortisone.

Clark, J.D. (1990). **Research studies in exercise and behavior of dogs.** In: *Canine Research Environment* J.A. Mench and L. Krulisch eds., Scientists Center for Animal Welfare: Greenbelt, MD, pp. 61-65.
NAL call number: QL737.C22C36
Descriptors: confinement systems, housing, experimental design, EKG, muscle enzyme, behavior.

Corbett, L.K. (July 1988). **Social dynamics of a captive dingo pack: Population regulation by dominant female infanticide.** *Ethology* 78(3):177-198.
NAL call number: QL750.E74
Descriptors: animal dominance, animal social behavior, animal environments, infanticide, dogs, social density, dominance hierarchy.

DeLuca, A.M. and K.C. Kranda (January 1992). **Environmental enrichment in a large animal facility.** *Lab Animal* 21(1):38-44.
NAL call number: QL55.A1L33
Descriptors: dogs, cats, swine, gumadisc, nylabone frisbee, plastic chain, decoys, gumabone tug, catnip, sheepskin mice, balls, bells, cotton tugs, scented apples.

Falt, L. and E. Wilsson (1979). **The effect of maternal deprivation between 6 and 10 weeks of age upon the behaviour of Alsatian puppies.** *Applied Animal Ethology* 5(3):299.
NAL call number: QL750.A6
Descriptors: service dogs, training methods, early experience.

Feddersen, D.P. (January 1991). **Behavior disorders in dogs, study of their classification. [Verhaltensstorungen bei hunden, versuch ihrer klassifizierung.]** *DTW Deutsche Teirarztliche Wochenschrift* 98(1):15-19.
NAL call number: 41.8 D482
Descriptors: behavior, bonding, human isolation, dogs.

Feldhaus, R.A. (1980). **A resting platform for dog pens**. *Laboratory Animal Science* 30(4):714-715.
NAL call number: 410.9 P94
Descriptors: dogs, resting area, housing.

Fox, M.W. (1990). **Canine behavior**. In: *Canine Research Environment* J.A. Mench and L. Krulisch, eds., Scientists Center for Animal Welfare: Greenbelt, MD, pp. 21-31.
NAL call number: QL737.C22C36
Descriptors: ethology, socialization, exercise, housing, environment, psychological well-being.

Fox, M.W. (1986). ***Laboratory Animal Husbandry: Ethology, Welfare, and Experimental Variables***. State University of New York Press: Albany, NY., pp. 1-98.
NAL call number: SF406 F69
Descriptors: dogs, primates, rodents, cats, confinement effects, physical activity, stereotypies, cage size, brain development.

Fox, M.W. (1971). **Effects of rearing conditions on the behavior of laboratory animals.** M.W. In: *Defining the Laboratory Animal* National Academy of Sciences: Washington, DC, pp. 294-312.
NAL call number: SF406 I52
Descriptors: selective breeding, genotype, handling, socialization, temperament, isolation, exercise.

Fox, M.W. (1969). **Behavioral effects of rearing dogs with cats during the critical period of socialization.** *Behaviour* 35(3-4):273-280.
NAL call number: 410 B393
Descriptors: intra-species socialization, intra-species, identification, avoidance, recognition, bonding.

Fox, M.W. (1965). **Environmental factors influencing stereotyped and allelomimetic behavior in animals.** *Laboratory Animal Care* 15(5):363-370.
NAL call number: 410.9 P94
Descriptors: review, dogs, rodents, poultry, behavior, social isolation, social stimulation, crowding.

Frank, H. and M.G. Frank (1982). **On the effects of domestication on canine social development and behavior.** *Applied Animal Ethology* 8(6):507-525.
NAL call number: QL750.A6
Descriptors: social behavior, social organization, domestication, *Canis lupus*, lycaon, effects on dogs.

Garnier, F., E. Benoit, M. Virat, R. Ochoa, and P. Delatour (January 1990). **Adrenal cortical response in clinically normal dogs before and after adaptation to a housing environment.** *Laboratory Animals* 24(1):40-43.
NAL call number: QL55.A1L3
Descriptors: dogs, sex differences, hydrocortisone, blood serum, stress, adaptation, environmental factors, susceptibility.

Gartner, K., W. Kupper, and J. Maess (1976). **Type-specific locomotive requirements of laboratory animals (mouse, rat, guinea pig, rabbit, dog, cat). [Zum artgemassen bewegungsbedurfnis der versuchstiere (maus, ratte, meerschweinchen, kaninchen, hund, katze).]** *Fortschritte der Veterinarmedizin* (No.25):130-137.
NAL call number: 41.8 Z5
Descriptors: mouse, rat, guinea pig, rabbit, dog, cat, legislation, behavior, stress, exercise, laboratory animals, animal welfare, cages, housing.

Garvey, M.S. (1985). **Keeping your dog healthy.** In: *The Complete Book of Dog Health* W.J. Kay and E. Randolph, eds., Macmillan Publishing Company: New York, NY, pp. 52-53.
Descriptors: dog owner's book, toys, games, exercise.

Goddard, M.E. and R.G. Beilharz (November 1985). **Individual variation in agonistic behaviour in dogs.** *Animal Behaviour* 33(4):1338-1342.
NAL call number: 410.B77
Descriptors: dogs, stimuli, animal behavior, social behavior, aggression, fear.

Goodfellow, K.G. (April 1992). **Care and welfare of pre-weaning beagle puppies in a commercial breeding colony.** *Animal Technology: Journal of the Institute of Animal Technology* 43(1):49-55.
NAL call number: QL55.I5
Descriptors: puppies, laboratory rearing, breeding colony, husbandry, animal welfare.

Gross, W.B. (1980). **The benefits of tender loving care.** *International Journal of the Study of Animal Problems* 1(3):147-148.
Descriptors: socialization, human-animal bond, canines.

Guide for the Care and Use of Laboratory Animals (1985). U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health: Bethesda, MD; NIH Publication No. 86-23, pp. 11-31.
NAL call number: SF406 N32 1985
Descriptors: guidelines, policy, husbandry, facilities, laboratory management.

Hetts, S., J.D. Clark, J.P. Calpin, C.E. Arnold, and J.M. Mateo. (July 1992) **Influence of housing conditions on beagle behaviour.** *Applied Animal Behaviour Science* 4(1/2):137-155.
NAL call number: QL750.A6
Descriptors: dogs, pens, cages, animal housing, animal behavior, social interaction, isolation, space requirements, animal welfare.

Hetts, S. (March 1991). **Psychologic well-being: Conceptual issues, behavioral measures, and implications for dogs.** *Veterinary Clinics of North America: Small Animal Practice* 21(2):369-387.
NAL call number: SF601.V523
Descriptors: Animal Welfare Act, regulations, history, physical and psychic well-being, measures, indicators, abnormal behavior, normal behavior, preference testing, caging, socialization.

Hite, M., H. M. Hanson, N. R. Bohidar, P. A. Conti, and P. A. Mattis (1977). **Effect of cage size on patterns of activity and health of beagle dogs.** *Laboratory Animal Science* 27(1):60-64.
NAL call number: 410.9 P94
Descriptors: weight gain, activity patterns, standing, lying, sitting, sleeping, electrocardiograph, examinations, ophthalmic, hematologic, biochemical measurements.

Houpt, K.A. (1983). **Applied canine and feline ethology.** *Applied Animal Ethology* 10(1/2):1-157.
NAL call number: QL750.A6
Descriptors: aggression, mating behavior, young animals, animal behavior, cat, dog, differential rearing.

Hubrecht, R.C. (February 1995). **Enrichment in puppyhood and its effects on later behavior of dogs.** *Laboratory Animal Science* 45(1):70-75.
NAL call number: 410.9 P94
Descriptors: early socialization, human contact, toys, chews, plastic pipe.

Hubrecht, R.C. (1993). **A comparison of social and environmental enrichment methods for laboratory housed dogs.** *Applied Animal Behaviour Science* 37(4):345-361.
NAL call number: QL750.A6
Descriptors: activity pattern, toys, psychological well-being, socialization session.

Hubrecht, R.C. (1993). ***Dog Housing and Welfare: UFAW Animal Research Report No. 6***, Universities Federation for Animal Welfare (UFAW): Potters Bar, Herts, UK, 13p.
Descriptors: welfare, behavior, socialization, stereotypies, enrichment, toys.

Hubrecht, R.C., J.A. Serpell, and T.B. Poole (September 1992). **Correlates of pen size and housing conditions on the behaviour of kennelled dogs.** *Applied Animal Behaviour Science* 34(4):365-383.
NAL call number: QL750.A6
Descriptors: dogs, kennels, cage size, animal behavior, shelters, laboratories, social behavior, animal housing, animal welfare.

Hughes, H.C., S. Campbell, and C. Kenney (July 1989). **The effects of cage size and pair housing on exercise of beagle dogs.** *Laboratory Animal Science* 39(4):302-305.
NAL call number: 410.9 P94
Descriptors: dogs, animal housing, cage size, cage density, exercise, animal welfare, regulations.

Hughes, H.C. and S. Campbell (1990). **Effects of primary enclosure size and human contact.** In: *Canine Research Environment* J.A. Mench and L. Krulisch, eds., Scientists Center for Animal Welfare: Greenbelt, MD, pp. 66-75.
NAL call number: QL737.C22C36
Descriptors: dogs, laboratory animals, animal housing, socialization, animal welfare.

Institute of Laboratory Animal Resources (1994). **Husbandry**. In: *Laboratory Animal Management: Dogs* Committee on Dogs, Institute of Laboratory Animal Resources, National Research Council, National Academy Press: Washington, D.C., pp. 11-34.
Descriptors: Animal Welfare Act, exercise, environmental enrichment, space recommendations, feeding, water, enclosures.

Korhonen, H., and M. Harri (1988). **Social influences on productive performance in farmed raccoon dogs.** *Acta Agriculturae Scandinavica* 38(4):433-440.
NAL call number: 11 AC82
Descriptors: cage size, body weight, feed intake, tameness score, fur quality.

Korhonen, H., M. Harri, and L. Nurminen (Autumn 1986). **Effects of social competition for feed on growth of farmed raccoon dogs.** *Growth* 50(3):340-350.
Descriptors: dogs, competitive behavior, physiology, feeding.

Korhonen, H. (1988). **Activity and behavior of farmed raccoon dogs.** *Scientifur* 12(1):27-37.
NAL call number: SF402 S3
Descriptors: circadian activity, behavioral patterns, rhythms, eating, elimination, aggression, environmental conditions.

Kuhn, G. and W. Hardegg (1988). **Effects of indoor and outdoor maintenance of dogs upon food intake, body weight, and different blood parameters.** *Zeitschrift für Versuchstierkunde* 31(5):205-214.
NAL call number: 410 Z36
Descriptors: environment, red blood cell counts, packed cell volume, hemoglobin, plasma enzymes, substrates, minerals.

LaBarge, L. (1977). ***The pet house book: How to build housing, accessories, and playthings for your dogs, cats, birds, lizards, hamsters, and other pets.*** Butterick Pub.: New York, NY, 200p.
NAL call number: SF414.2.L32
Descriptors: pets, housing, design and construction, pet supplies, building, amateurs' manuals, handicraft.

Lore, R.K. and F.B. Eisenburg (June 1986). **Avoidance reactions of domestic dogs to unfamiliar male and female humans in a kennel setting.** *Applied Animal Behaviour Science* 15(3):261-266.
NAL call number: QL750.A6
Descriptors: human sex differences, animal sex, familiarity.

Luescher, U.A. (March 1991). **Stereotypic and obsessive-compulsive disorders in dogs and cats**. *Veterinary Clinics of North America: Small Animal Practice*. 21(2):401-413.
NAL call number: SF601.V523
Descriptors: excessive grooming, stone chewing, wool sucking, polydipsia, barking, tail or foot biting, aggression, environmental enrichment.

MacDonald, K.B. and B.E. Ginsburg (October 1981). **Induction of normal prepubertal behavior in wolves with restricted rearing.** *Behavioral and Neural Biology* 33(2):133-162.
NAL call number: QH301 C63
Descriptors: wolves, animal social behavior, social isolation, handling, infants (animal).

Mahut, H. (1958). **Breed differences in the dog's emotional behaviour**. *Canadian Journal of Psychology* 12(1):35-44.
Descriptors: genetics, behavior, breed differences, exercise.

Markwell, P.J. and C.J. Thorne (November 1987). **Early behavioural development of dogs.** *The Journal of Small Animal Practice* 28(11):984-991.
NAL call number: 41.8 J8292
Descriptors: socialization period, responses to environment, sensory isolation, play.

Milnes, S. (February 1992). **Danger from toys?** *Veterinary Record* 130(8):168.
NAL call number: 41.8 V641
Descriptors: dog, tongue injury, playthings, case report.

Netto, W.J., J.A. van der Borg, and J.F. Slegers (April 1992). **The establishment of dominance relationships in a dog pack and its relevance for the man-dog relationship.** *Tijdschrift voor Diergeneeskude* 117(Supplement 1):51S-52S.
NAL call number: 41.8 T431
Descriptors: bonding, posture, behavior, social dominance.

Nakano, L. (October 1979). **The effects of spatial restriction on the behavior of random-source dogs.** *Dissertation Abstracts International* 40(4,B):1932.
NAL call number: Z5055 U49D53
Descriptors: dogs, animal environments, environmental stress, animal ethology.

Neamand, J., W.T. Sweeney, A.A. Creamer, and P.A. Conti. (1975) **Cage activity in the laboratory beagle: A preliminary study to evaluate a method of comparing cage size to physical activity.** *Laboratory Animal Science* 25:180-183.
NAL call number: 410.9 P94
Descriptors: physical activity, specific activity measurements, body weight, blood chemical and urine values.

Newton, W.M. (1972). **An evaluation of the effects of various degrees of long-term confinement on adult beagle dogs.** *Laboratory Animal Science* 22(6):860-864.
NAL call number: 410.9 P94
Descriptors: exercise, dog, cage confinement, musculoskeletal system, dogs kept in cages, muscle, enzymes.

O'Farrell, V. (1991). **Behavioural problems in companion animals.** In: *Managing the Behaviour of Animals* P. Monaghan, D. Wood-Gush, eds., Chapman and Hall: London and New York, pp. 233-252.
NAL call number: QL751 M218 1990
Descriptors: pets, behavior, management, reviews.

O'Farrell, V. (1990). **Behaviour problems in the dog: Aggression towards people.** *Veterinary Annual* 30:196-199.
NAL call number: 41.8 V6456
Descriptors: exercise, aggression, human-animal bond.

Pettijohn T.F., T.W Wong, P.D Ebert, and J.P. Scott (1977). **Alleviation of separation distress in three breeds of young dogs.** *Developmental Psychobiology* 10:(4):373-381
NAL call number: QP351.D4
Descriptors: Shetland sheepdogs, telomians, beagles, food, toys, human contact, canine contact, distress vocalizations, isolation.

Pettijohn, T.F., K.L. Davis and J.P. Scott (1980). **Influence of living area space on agonistic interaction in Telomian dogs.** *Behavioral and Neural Biology* 28(3):343-349.
NAL call number: QH301 C63
Descriptors: aggression, crowding, dominance, eating, spatial behavior.

Pgurski J.C., K. Davis, and J.P. Scott (1980). **Interaction of separation discomfort with contact comfort and discomfort in the dog.** *Developmental Psychobiology* 13(5):463-467.
NAL call number: QP351.D4
Descriptors: social attachment, beagles, Telomians, separation distress.

Porschen, H. (1975). **Keeping dogs, shortcomings observed and proposals for improvement. [Die hundehaltung, beobachtete mangel und verbesserungsvorschlage.]** *Praktische Tierarzt* 56(12):752, 754-755.
NAL call number: 41.8 P882
Descriptors: housing, husbandry, animal welfare, dog, pets.

Samuels, W.M. (April 1991). **Animal welfare regulations for exercising dogs, psychological wellbeing of primates assailed.** *Physiologist* 34(2):42-43.
NAL call number: 447.8 P564
Descriptors: legislation, physical conditioning, dogs, housing, primates.

Schilder, M.B. (April 1992). **Stress and welfare and its parameters in dogs.** *Tijdschrift voor Diergeneeskunde* 117(Supplement 1):53S-54S.
NAL call number: SF601 N4
Descriptors: definitions, measurement, parameters, coping, adaptation, stress psychology.

Scott, J.P., J.H. Shepard, and J. Werboff (1967). **Inhibitory training of dog: Effects of age at training in basenjis and shetland sheepdogs.** *Journal of Psychology* 66(2):237-252.
Descriptors: dogs, education, socialization with humans, age differences.

Siefert, J. (1976). **Humane housing of dogs in cages and boxes. [Untersuchungen zur tierschutzgerechten haltung von hunden in kafigen und boxen.]** Tierärztliche Hochschule, *Inaugural Dissertation*, Hannover. 1976. 69pp.
NAL call number: 41.2 H198 [1976 No. 72]
Descriptors: dissertation, animal housing, animal welfare, cage, dog.

Sigg, H. and I. Tobler (1986). **Motor activity of mongrel dogs under three different housing conditions. [Motorische aktivitat von bastardhunden in 3 verschiedenen laborhaltungen.]** *Zeitschrift für Versuchstierkunde* 28(4):157-165.
NAL call number: 410 Z36
Descriptors: dogs, animal housing, movements, dark, light, kinetic energy.

Slabbert, J.M. and O.A.E. Rasa (March 1993). **The effect of early separation from the mother on pups in bonding to humans and pup health.** *Journal of the South African Veterinary Association* 64(1):4-8.
NAL call number: 41.8 So8
Descriptors: disease susceptibility, separation stress, mortality, weight gain.

Smith, C.P. (1994). ***The Dog: January 1985-January 1994.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 93p.
NAL call number: aZ5071.N3 no.94-24
Descriptors: bibliography, behavior, welfare, stress, nutrition, exercise.

Swanson, J.C. (October 1991). ***Exercise for Dogs*** *Special Reference Briefs 92-02* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 24p.
NAL call number: aS21.D27S64 no.92-02
Descriptors: bibliography, regulatory issues, physiology, behavior, husbandry, standard values.

Tellington-Jones, L. (1994). ***T-touch for Dogs.*** Thane Marketing International: La Quinta, CA, VHS, 84 minutes.
NAL call number: Videocassette no. 2040
Descriptors: stress, handling, relaxation, training, behavior, body awareness.

Thimm, H. J. and M. Potokar (1976). **A new compound kennel construction with unlimited circuit for keeping laboratory dogs. [Ein neues konzept zur tierschutzgerechten haltung von versuchschunden:Die verbundkafiganlage mit unbegrenztem Lauf.]** *Kleintier Praxis* 21(6):226-232.
NAL call number: 41.8 K67
Descriptors: cages, animal welfare, zootechny, dog, animal housing, laboratory animals.

Thomas, K.J., O.D. Murphee and J.E. Newton. **Effect of person and environment on heart rates in two strains of pointer dogs.** *Conditional Reflex* 7(2):74-81.
Descriptors: petting, human presence, bradycardia, genetics.

Tipton, C.M., R.A. Carey, W.C. Eastin, H.H. Erickson (1974). **A submaximal test for dog: Elevation of effects of training, detraining, and cage confinement.** *Journal of Applied Physiology* 37(2):271-275.
NAL call number: 447.8 J825
Descriptors: dog, training, heart rate, blood circulation, exercise, heart, atropine.

Unshelm, J. (1993). **Keeping dogs and cats in conditions which comply with animal welfare with the support of behavioral advice and therapy.** *DTW Deutsche Teirärztliche Wochenschrift* 100(2):65-69.
NAL call number: 41.8 D482
Descriptors: housing, behavior, companion animals.

Unshelm, J. (February 1993). **Raising dogs and cats in compliance with animal welfare using advice on behavior therapy. [Tiergerechte haltung von hunden und katzen durch erhaltensberatungen und verhaltenstherapie.]** *DTW Deutsche Teirärztliche Wochenschrift* 100(2):65-69.
NAL call number: 41.8 D482
Descriptors: animal welfare, behavior, cats, dogs, housing.

Vanderlip, S.L., J.E. Vanderlip, and S. Myles (1985). **A socializing program for laboratory-raised canines. Part 2: The puppy socialization schedule.** *Lab Animal* 14(2):27-32.
NAL call number: QL55.A1L33
Descriptors: puppies, socialization, human-animal bond, toys.

Vanderlip, S.L., J.E. Vanderlip, and S. Myles (March 1985). **A socializing program for laboratory-raised canines.** *Lab Animal* 14(1):33-36
NAL call number: QL55.A1L33
Descriptors: behavior, temperament testing, toys, knotted towel, plastic bottles, food rewards.

Wolfle, T.L. (November 1989). **Dog socialization.** In: *Animal Care and Use: Policy Issues in the 1990's.* NIH, OPRR, OACU Conference: Bethesda, Maryland, pp. 43-45.
NAL call number: HV4704 A46 1989
Descriptors: exercise, stress, bonding, human interaction.

Wolfle, T.L. (1990). **Policy, program and people: The three P's to wellbeing.** In: *Canine Research Environment* J.A. Mench and L. Krulisch (eds.), Scientists Center for Animal Welfare: Greenbelt, MD, pp. 41-47.
NAL call number: QL737.C22C36
Descriptors: psychological well-being, exercise, socialization, management, performance vs. engineering standards.

Wright, J.C. (1980). **The development of social structure during the primary socialization period in German shepherds.** *Developmental Psychobiology* 13(1):17-24.
NAL call number: QP351 D4
Descriptors: social organization, exploratory behavior, ontogeny, dominance, dogs.

Wright, J.C. (1983). **The effects of differential rearing on exploratory behavior in puppies.** *Applied Animal Ethology* 10(1-2):27-34.
NAL call number: QL750.A6
Descriptors: hand-rearing, litter-rearing, stimulus, exploratory behavior, locomotor activity, novel objects, reactivity, social environment, rearing, exploratory behavior, dogs.

Wubs, W. and H. Rozemond (October 15, 1987). **Experimental dog: A need for improvement in housing. [Proefhonden: Noodzaak tot verbetering van de huisvesting.]** *Tijdschrift voor Diergeneeskunde* 112(20):1182-1190.
NAL call number: SF601 N4
Descriptors: animal welfare, laboratory animals, physiology, dogs, housing, standards, quality control.

Farm Animals

ENRICHMENT FOR FARM ANIMALS

Michael C. Appleby
Institute of Ecology and Resource Management
University of Edinburgh, Edinburgh EH9 3JG, United Kingdom

There has been relatively little published on environmental enrichment for the mammalian farm animals used in "laboratory" studies. This may be partly because most such studies are carried out either in normal farm conditions, or in conditions regarded as similar to these (for example, growing pigs housed singly, similar to normal housing for sows) or on animals removed only temporarily from such conditions. There may, however, be welfare problems in normal farm conditions and the considerable work which has now been done on improvement of these is relevant here. In addition, the special treatment necessary for experimental work may cause further problems and also cast doubt on the results of the research, not least when imposed temporarily. In this brief commentary, three aspects of such treatment will be considered which act separately and in combination: human contact, social conditions and physical conditions.

Human contact

Animals react to human contact behaviorally and physiologically in ways which may interfere with the topic under study. This is particularly likely if restraint is involved; for example, to obtain blood samples. A common approach to minimize such effects is to use remote sampling methods such as filming behavior, strapping on or implanting heart rate meters (Porges 1985), and automatically withdrawing blood samples from a catheter (Mayes *et al.* 1988). Other non-invasive techniques are also being developed, such as measurement of hormones in saliva, urine and faeces. Less attention has been given to the possibility of accustoming animals to human contact including handling, which may considerably reduce such effects (Pearce *et al.* 1989), despite the fact that more is known about this for farm animals than for other species (Gonyou 1991). A particularly promising finding is that pigs and sheep can be trained to enter a restraining device for procedures including blood withdrawal voluntarily and repeatedly (Grandin 1986, 1989). Another important aspect of human contact is predictability (Carlstead 1986). Thus if feeding times are to be manipulated experimentally, animals can be trained in advance not to expect food at the same time each day (Reid and Mills 1962). As a general rule it is better to accustom animals to disturbance than to attempt to avoid disturbing them; if there is little disturbance for long periods then any disruption which does occur may be very stressful. This is probably the main basis of the idea which is sometimes expressed that animals should be

subjected to "adequate levels of stress".

Social conditions

Many experiments involve isolation of animals. This can have very strong effects: heart rate of sheep when first isolated is greatly elevated (Baldock and Sibly 1986) and sheep on restricted diets behave more abnormally in isolation than in groups (Done-Currie *et al.* 1984). There is some indication that the chance of conception by dairy cows is lower if they have been kept in isolation prior to artificial insemination (cf. Moberg 1991). Effects are usually reduced if animals can see each other and it should be possible to arrange this even in restrictive housing such as metabolism crates. More consideration should also be given to methods for housing animals in groups while making individual measurements; for example, using film (Pajor *et al.* 1991) or electronic devices (Lambert *et al.* 1983) for recording individual food intake. When animals are housed in groups, though, care must be taken to minimize harmful social behavior such as aggression, as in any husbandry system. Precautions should include careful consideration of physical conditions.

Physical conditions

The space provided in experimental conditions is usually less constrained than that in commercial conditions with one major exception: the metabolism crate. This is commonly used to keep the animal in a fixed position for collection of urine and faeces, but more use could be made of bags fixed to the animal for this purpose; in pigs, it should also be possible to make use of their habitual urination and defecation sites as has been done for cats (Carlstead *et al.* 1993). Reactions of animals to close confinement may be extreme especially if it is combined with food restriction (Appleby *et al.* 1987). In experiments which do not use such crates, problems such as harmful social behavior and frustration of various behavior patterns are more likely to be associated with barrenness of the environment than with lack of space. Common causes for barrenness are cleanliness and avoidance of unwanted edible material (such as straw). Yet cleanliness is not always strictly necessary, and an acceptable degree of cleanliness may be achieved even with substrates such as woodchips (Chamove *et al.* 1982). The environment can be made more complex quite easily, for example by fitting barriers (Waran and Broom 1993) and providing manipulable objects. Many techniques which have been developed for other species such as primates could also be used for farm animals; these include, for example, increasing the animals' control over their physical environment (Baldwin 1979). Among other advantages, provision of "toys" makes handling of pigs easier (Grandin *et al.* 1987). It should be pointed out, however, that the effects of environmental enrichment need to be assessed rather than just assumed; there may be deleterious effects such as increased aggression (McGregor and Ayling 1990). Food can

also be provided in ways which are more stimulating than a trough, such as operant devices. As with several of the other factors already mentioned, this will be particularly valuable if food is restricted. Without such measures, food restriction can have severe effects on behavior (Willard *et al.* 1977, Appleby and Lawrence 1987) with implications for physiological effects on the measurements being made (Marsden and Wood-Gush 1986). Such effects include extreme variability: one nutritional study of sheep which kept them without food for a period to obtain baseline measurements found that some reacted violently, with high metabolic rate, while others were somnolent with low metabolism (Blaxter and Wainman 1961).

Environmental enrichment for farm animals in experiments is important both for the validity of the experiments and for the animals themselves.

References

Appleby, M.C. and A.B. Lawrence (1987). **Food restriction as a cause of stereotypic behaviour in tethered gilts.** *Animal Production* 45:103-110.

Baldock, N.M. and R.M. Sibly (1986). **Effects of management procedures on heart rate in sheep.** *Applied Animal Behaviour Science* 15:191.

Baldwin, B.A. (1979). **Operant studies on the behaviour of pigs and sheep in relation to the physical environment.** *Journal of Animal Science* 49: 1125-1134.

Blaxter, K.L. and F.W. Wainman (1961). **The utilization of food by sheep and cattle.** *Journal of Agricultural Science* 57:419-425.

Carlstead, K. (1986). **Predictability of feeding: Its effects on agonistic behaviour in grower pigs.** *Applied Animal Behaviour Science* 16:25-38.

Carlstead, K., J.L. Brown, and W. Strawn (1993). **Behavioral and physiological correlates of stress in laboratory cats.** *Applied Animal Behaviour Science* 38:143-158.

Chamove, A.S., J.R. Anderson, S.C. Morgan-Jones, and S.P. Jones (1982). **Deep woodchip litter: Hygiene, feeding, and behavioral enhancement in eight primate species.** *International Journal for Study of Animal Problems* 3: 308-318.

Done-Currie, J.R., J.F. Hecker, and M. Wodzicka-Tomaszewka (1984). **Behaviour of sheep transferred from pasture to an animal house.** *Applied Animal Behaviour Science* 12:121-130.

Gonyou, H.G. (1991). **The interaction of humans with food animals: Making husbandry a science.** In: *Applied Animal Behaviour: Past, Present and Future* Appleby, M.C., R.I. Horrell, J.C. Petherick, and S.M. Rutter, eds., Universities Federation for Animal Welfare: Potters Bar, UK, pp. 31-33.

Grandin, T. (1986). **Minimizing stress in pig handling.** *Lab Animal* 15:1-5.

Grandin, T. (1989). **Voluntary acceptance of restraint by sheep.** *Applied Animal Behaviour Science* 23:257-261.

Grandin, T, S.E. Curtis, and I.A. Taylor (1987). **Toys, mingling and driving reduce excitability in pigs.** *Journal of Animal Science* 65(Supplement 1):230.

Lambert, R. J., M. Ellis, P. Rowlinson, and C.A. Saville (1983). **An alternative system of sow housing and feeding based upon a sow activated feeder.** *Animal Production* 36:532.

Marsden, D. and D.G.M. Wood-Gush (1986). **A note on the behaviour of individually-penned sheep regarding their use for research purposes.** *Animal Production* 42:157-159.

Mayes, R.W., C.S. Lamb, and P.M. Colgrove (1988). **Equipment for estimating carbon dioxide turnover rate in undisturbed grazing sheep.** *Proceedings of the Nutrition Society* 47:136a.

McGregor, P.K. and S.J. Ayling (1990). **Varied cages result in more aggression in male CFLP mice.** *Applied Animal Behaviour Science* 26:277-281.

Moberg, G.P. (1991). **How behavioral stress disrupts the endocrine control of reproduction in domestic animals.** *Journal of Dairy Science* 74:304-311.

Pajor, E.A, D. Fraser, and D.L. Kramer (1991). **Consumption of solid food by suckling pigs: Individual variation and relation to weight gain.** *Applied Animal Behaviour Science* 32:139-155.

Pearce, G.P., A.N. Pearce, and A.M. Paterson (1989). **The influence of pleasant and unpleasant handling and the provision of toys on the growth and behaviour of male pigs**. *Applied Animal Behaviour Science* 23:27-37.

Porges, S.W. (1985). **Spontaneous oscillations in heart rate: Potential index of stress.** In: *Animal Stress* G.P. Moberg, ed., American Physiological Society: Bethesda, Maryland, pp. 97-111.

Reid, R.L. and S.C. Mills (1962). **Studies on the carbohydrate metabolism of sheep: The adrenal response to psychological stress.** *Australian Journal of Agricultural Research* 13:282-295.

Waran, N.K. and D.M. Broom (1993). **The influence of a barrier on the behaviour and growth of early-weaned piglets.** *Animal Production* 56:115-119.

Willard, J.G, J.C. Willard, S.A. Wolfram, and J.P. Baker (1977). **Effect of diet on cecal pH and feeding behavior of horses.** *Journal of Animal Science* 45:87-93.

FARM ANIMAL BIBLIOGRAPHY

GENERAL

Berry, D.J. (1994). ***Transport and Handling of Livestock and Poultry: January 1984 - January 1994.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 62p.
NAL call number: aZ5071.N3 no. 94-32
Descriptors: bibliography, livestock, poultry, handling, husbandry, transport, care.

Cregier, S.E. (1989). ***Farm Animal Ethology: A Source Book.*** Captus Press: Ontario, Canada, 213p.
NAL call number: SF81 C73
Descriptors: directory, information, journals, funding sources, academia, audio-visuals, conferences, books, reviews.

DeLuca, A.M. and C. Kranda (1992). **Environmental enrichment in a large animal facility.** *Lab Animal* 21(1):38-44.
NAL call number: QL55 A1L33
Descriptors: canine, swine, feline, welfare, exercise, toys, play, balls, runs, comparisons.

Ewbank, R. (1985). **The behavioural needs of farm and laboratory animals**. In: *Animal Experimentation: Improvements and Alternatives* N. Marsh and S. Heywood, eds., FRAME: Nottingham, UK, pp. 31-35.
NAL call number: QL55 A5
Descriptors: behavioral needs, comfort, shelter, flooring, legislation.

Fox, M.W. (1965). **Environmental factors influencing stereotyped and allelomimatic behavior in animals.** *Laboratory Animal Care* 15(5):363-370.
NAL call number: 410.9 P94
Descriptors: boredom, crowding, space, noise, photoperiod.

Grandin, T. (April 1993). **The effect of previous experiences on livestock behavior during handling**. *Agri-Practice* 14(4):15-20.
NAL call number: SF601.B6
Descriptors: cattle, sheep, handling, restraint, behavior.

Grandin, T. (November 1990). **Design of loading facilities and holding pens.** *Applied Animal Behaviour Science* 28(1/2):187-201.
NAL call number: QL750.A6
Descriptors: cattle, pigs, sheep, floor, lighting, chutes, pens, transport.

Grandin, T. (July 1987). **Animal handling.** *The Veterinary Clinics of North America: Food Animal Practice* 3(2):323-338.
NAL call number: SF601.V535
Descriptors: livestock, handling, stress, movement, behavior, facilities.

Grandin, T. (June 1984). **Reduce stress of handling to improve productivity of livestock.** *Veterinary Medicine and Small Animal Clinician* 79(6):827-831.
NAL call number: 41.8 M69
Descriptors: cattle, physiology, stress, behavior.

Hart, L.A. (February 1994). **Opportunities for environmental enrichment in the laboratory.** *Lab Animal* 23(2):24-27.
NAL call number: QL55 A1L33
Descriptors: zoo, farm, laboratory, outdoor housing, noise.

Hemsworth, P.H., J.L. Barnett, and G.J. Coleman (1993). **The human-animal relationship in agriculture and its consequences for the animal.** *Animal Welfare* 2(1):33-51.
NAL call number: HV4701.A557
Descriptors: stock people, human-animal bond, fear, handling.

Hemsworth, P.H. and J.L. Barnett (1987). **Human-animal interactions.** In: *Farm Animal Behaviour. The Veterinary Clinics of North America - Food Animal Practice* 3(2):339-356.
NAL call number: SF601 V535
Descriptors: fear, handling, noise, husbandry, housing.

Hughes, B.O. and I.J.H. Duncan (1988). **The notion of ethological "need," models of motivation and animal welfare.** *Animal Behaviour* 36:1696-1707.
NAL call number: 410 B77
Descriptors: behavioral elasticity, motivation, appetitive and consummatory behavior.

Kilgour, R., T.M. Foster, W. Temple, L.R. Matthews, and K.J. Bremner (April 1991). **Operant technology applied to solving farm animal problems. An assessment.** *Applied Animal Behaviour Science* 30(1/2):141-166.
NAL call number: QL750.A6
Descriptors: cattle, goats, horses, sheep, pigs, feed preferences, conditioning.

Mench, J.A. (February 1994). **Environmental enrichment and exploration.** *Lab Animal* 23(2):38-41.
NAL call number: QL55 A1L33
Descriptors: exploratory behavior, appetitive behavior, genetics, experience.

Mench, J.A., S.J. Mayer, and L. Krulisch, eds. (1992). ***The Well-being of Agricultural Animals in Biomedical and Agricultural Research*** Scientists Center for Animal Welfare: Greenbelt, MD, 111p.
NAL call number: HV4704.W38
Descriptors: handling, transport, management, care, behavior, regulations.

Purdue University (1993). ***Normal and Abnormal Behavior in Domestic Livestock Used for Research.*** Department of Animal Science: West Lafayette, Indiana, videorecording, 41 minutes.
NAL call number: videocassette no. 1542
Descriptors: farm animals, pointless behavior, physiology, genetics, parasites, nutritional deficiencies.

Universities Federation for Animal Welfare (1990). Environmental Enrichment Advancing Animal Care. UFAW: Potters Bar, Herts, England, videorecording, 37 minutes.
NAL call number: videocassette no. 1327
Descriptors: zoo animals, housing, guidelines, captivity

Wood-Gush, D.G.M. and K. Vestergaard (1991). **The seeking of novelty and its relation to play.** *Animal Behaviour* 42:599-606.
NAL call number: 410 B77
Descriptors: novel objects, exploration, learning.

Wood-Gush, D.G.M. and K. Vestergaard (1989). **Exploratory behavior and the welfare of intensively kept animals.** *Journal of Agricultural Ethics* 2:161-169.
NAL call number: BJ52.5 J68
Descriptors: pigs, exploration, learning, social behavior, housing.

CATTLE

Albright, J.L., T.H. Blosser, and S.E. Curtis (1987). **Dairy animal welfare: Current and needed research.** *Journal of Dairy Science* 70(12):2711-2731.
NAL call number: 44.8 J822
Descriptors: cows, welfare, review, housing, environment, behavior, environmental factors.

Berry, D.J. (1995). ***Housing, Husbandry, and Welfare of Beef Cattle: January 1985-March 1995.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 92p.
NAL call number: aZ5071.N3 no. 95-16
Descriptors: bibliography, handling, husbandry, facilities, care, welfare, well-being, behavior, stress, humane.

Berry, D.J. (1995). ***Housing, Husbandry, and Welfare of Dairy Cattle: January 1985 - March 1995.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 92p.
NAL call number: aZ5071.N3 no. 95-15
Descriptors: bibliography, handling, husbandry, facilities, care, welfare.

Berry, D.J. (1992). ***Veal Calves: January 1979 - August 1992.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 49p.
NAL call number: aZ5071.N3 no. 92-67
Descriptors: bibliography, handling, husbandry, facilities, care, welfare, behavior, stress, humane.

Boandl, K.E., J.E. Wohlt, and R.V. Carsia (August 1989). **Effects of handling, administration of a local anesthetic, and electrical dehorning on plasma cortisol in Holstein calves.** *Journal of Dairy Science* 72(8):2193-2197.
NAL call number: 44.8 J822
Descriptors: calves, handling, anesthesia, polling, cortisol, stress.

Brunner, C.J. (1989). **Reducing handling stress aids immune function in calves.** *Agricultural Experiment Station* 367(2):p.10.
NAL call number: 100 AL1H
Descriptors: calves, steers, cattle, stress management, stress response, adrenal cortex hormones, immune response, transport of animals.

de Wilt, J.G. (September 1987). **Behavior and welfare of veal calves in individual crates and in group pens. [Gedrag en welzijn van vleeskalveren in individuele boxen en in groepshuisvesting.]** *Tijdschrift voor Diergeneeskunde* 112(17):994-1000.
NAL call number: 41.8 T431
Descriptors: society critique, group vs. isolated housing, preputial sucking.

Eldridge, G.A., C.G. Winfield, and D.J. Cahill (1988). **Responses of cattle to different space allowances, pen sizes and road conditions during transport.** *Australian Journal of Experimental Agriculture* 28(2):155-159.
NAL call number: 23 AU792
Descriptors: cattle, stress response, space requirements, pens, size, behavior, welfare, heart rate, surveys, injuries, weight loss.

Gebremedhin, K.G., C.O. Cramer, and H.J. Larsen (September 1985). **Preference of dairy cattle for stall options in free stall housing.** *Agricultural Engineers* 28(5):1637-1640.
NAL call number: 290.9 AM32T
Descriptors: cattle, dairy, stalls, housing, behavior.

Grandin, T. (1991). **Cattle behavior during handling and corral design for beef cow herds.** *Extension Bulletin* Cooperative Extension Service, Michigan State University: East Lansing, Michigan, 10p.
NAL call number: 275.29 M58B
Descriptors: cows, cattle, fencing, behavior, vision, movement.

Grandin, T. (1987). **Using cattle psychology to aid handling.** *Agri-Practice* 8(5):32-36.
NAL call number: SF601.B6
Descriptors: cattle, handling, behavior, perception, stress, guidelines.

Heerens, S.E. (August 1989). **Confinement rearing of calves.** [Letter] *Journal of the American Veterinary Association* 195(4):423.
NAL call number: 41.8 AM3
Descriptors: housing, husbandry, pathogen transmission.

Hemsworth, P.H., J.L. Barnett, A.J. Tilbrook, and C. Hansen (1989). **The effects of handling by humans at calving and during milking on the behaviour and milk cortisol concentrations of primiparous dairy cows.** *Applied Animal Behaviour Science* 22(3/4):313-326.
NAL call number: QL750.A6
Descriptors: cattle, cows, milking interval, calving interval, handling, stress, cortisol, behavior.

Hinch, G.N. (1994). **The behavioural and physiological assessment of well-being, pain and distress in sheep and cattle**. In: *Improving the Well-being of Animals in the Research Environment: Proceedings of the conference held at the Marriott Hotel, Sydney, October, 1993* R.M. Baker, G. Jenkin, and D.J. Mellor, eds., ANZCCART, P.O. Box 19, Glen Osmond, SA, 5064, Australia, pp. 35-40.
Descriptors: stress, pain, social behavior, physiology, stereotypies.

Johnson, D.D., N.W. Bradley, J.A. Boling, and R.M. Stone (September 1983). **Effects of space and bedding on steer performance.** *Progress Report - Kentucky Agricultural Experiment Station* 272:17-18.
NAL call number: 100 K41PR
Descriptors: cattle, steers, housing, pens, bedding, space requirements.

Kerr, S.G.C. and D.G.M. Wood-Gush (1987). **A comparison of the early behaviour of intensively and extensively reared calves.** *Animal Production* 45(pt.2):181-190.
NAL call number: 49 AN55
Descriptors: calves, animal behavior, intensive livestock farming, extensive livestock farming, housing, welfare.

Lehenbauer, T., T. Jones, and L. Collar (1994). **The impact of free-stall housing on somatic cell counts in bulk tank milk.** In: *Dairy Systems for the 21st century. Proceedings of the third international dairy housing conference held in Orlando, Florida, February 2-5, 1994.* American Society of Agricultural Engineers, St. Joseph, MI, pp.128-137.
Descriptors: dry-lot housing, economic impact, milk production, housing, microclimate, milk quality, mastitis, design, loose housing, cattle diseases.

Martsching, S.L. (October 1989). **More on confinement rearing of calves**. [Letter] *Journal of the American Veterinary Association* 195(8):1055.
NAL call number: 41.8 AM3
Descriptors: housing, husbandry, pathogen transmission.

Mench, J.A., J.C. Swanson, and W.R. Stricklin (1990). **Social stress and dominance among group members after mixing beef cows.** *Canadian Journal of Animal Science* 70(2):345-354.
NAL call number: 41.8 C163
Descriptors: cattle, cortisol, socialization.

O'Connell, J., P.S. Giller, and W. Meaney (1989). **A comparison of dairy cattle behavioral patterns at pasture and during confinement.** *Irish Journal of Agricultural Research* 28(1):65-72.
NAL call number: S539.5.174
Descriptors: ethograms, feeding, social behavior, resting behavior.

Pagano, A., R. Holt, R. Schwart, W. Boggess, and M. DeLorenzo (1994). **Investments in free stall dairy housing: Estimated costs, returns and risk.** *Balanced Dairying Economics* 14(1):11pp.
Descriptors: cows, housing, construction, design, cost benefit analysis, dairy, loose housing, management.

Rodenburg, J., H.K. House, and N.G. Anderson (1994). **Free stall base and bedding materials: Effect on cow comfort.** *Annual Meeting: National Mastitis Council (U.S.)*
NAL call number: SF967.M3N32
Descriptors: dairy herds, cubicles, litter, welfare, hygiene, housing.

Rynk, R.F. (1988). **Performance of alternative veal housing systems.** In: *Livestock Environment III: Proceedings of the Third International Livestock Environment Symposium* St. American Society of Agricultural Engineers: Joseph, Michigan, pp. 409-416.
NAL call number: SF91.I5
Descriptors: calf housing, loose housing, husbandry, behavior, literature review.

Sato, S., K. Tarumizu, and K. Hatae (December 1993). **The influence of social factors on allogrooming in cows.** *Applied Animal Behaviour Science* 38(3/4):235-244.
NAL call number: QL750.A6
Descriptors: dairy cows, beef cows, grooming, kinship, social structure, spatial distribution, social interaction, altruism.

Schlichting, M., D. Smidt, and C. Muller (November 1990). **Studies of the effects of group housing of calves on their welfare.** *Tierärztliche Umschau* 45(11):785-791.
NAL call number: 41.8 T445
Descriptors: group housing, slat floors, litter, social behavior, calves.

Seabrook, M.F. (1984). **The psychological interaction between the stockman and his animals and its influence on performance of pigs and dairy cows.** *Veterinary Record* 115:84-87.
NAL call number: 41.8 V641
Descriptors: human-animal bond, fear, handling, behavior.

Smidt, D. (1990). **Animal welfare in cattle housing and pig housing and management.** *Landbauforschung Volkenrode* 40(2):138-156.
NAL call number: 18 L2353
Descriptors: alternative housing, species-specific feeding, economics, production.

Stricklin, W.R. (1976). **Theory and model for overcrowding effects on social animals.** *Canadian Journal of Animal Science* 56(4):849.
NAL call number: 41.8 C163
Descriptors: social behavior, aggression, housing, husbandry.

Tilbrook, A.J., P.H. Hemsworth, J.L. Barnett, and A. Skinner (1989). **An investigation of the social behavior and response to humans of young cattle.** *Applied Animal Behaviour Science* 23(1-2):107-116.
NAL call number: QL750.A6
Descriptors: bulls, steer, behavioral response, interaction, effects, husbandry/management practices.

Tsuji, O., Y. Matsuda, F. Tsuchiya, T. Suzuki, N. Abe, K. Oosaki, and K. Ooboshi (1994). **Study on drainage of cattle paddock: The improvement of cattle paddock environment with underdrainage.** *Research Bulletin of Obihiro University Natural Science* 19(1):23-29.
NAL call number: 513 Ob3
Descriptors: paddock drainage, footing, management, housing, environmental enrichment.

van Niekerk, A., A.W. Lishman, and S.F. Lesch (December 1986). **The reproductive responses of two breeds of beef cows and the performance of their progeny in two contrasting environments.** *South African Journal of Animal Science [Suid Afrikaanse tydskrif vir veekunde]* 16(4):209:214.
NAL call number: SF1.S6
Descriptors: beef cattle, simmental, calving, stress, environment.

Verga, M., M Pavesi, and F. Cerutti (1985). **Behaviour and performance of veal calves under different stabling conditions.** *Annales de Zootechnie* 34(3):247-256.
NAL call number: 49 F84
Descriptors: calves, behavior, housing, stables, slatted floors, pens, microclimate.

Voyt, J. (June 1984). **Good cattle handling facilities, less stress on man and beast alike.** *Georgia Cattleman* 12(6):12.
NAL call number: SF191.G4
Descriptors: corrals, chutes, headgates, enclosures, stress, behavior.

Webster, A.J., C. Saville, B.M. Church, A. Gnanasakthy, and R. Moss (May-June 1985). **The effect of different rearing systems on the development of calf behaviour.** *British Veterinary Journal* 141(3):249-264.
NAL call number: 41.8 V643
Descriptors: social behavior, age, housing.

HORSES

Barrey, E. (March 1989). **Comparative study of the comfort quality of different tracks for equestrian sports [Etude comparative des qualities de comfort de differents sols equestres.]** *Journee de la Recherche Chevaline* Cereeopa Publishers: Paris, France, pp.134-144.
Descriptors: welfare, racehorses, safety, preference, substrates.

Blackshaw, J.K., D. Kirk, and S.E. Cregier (April/June 1983). **A different approach to horse handling, based on the Jeffery method.** *International Journal for the Study of Animal Problems* 4(2):117-123.
NAL call number: HV4701.I49
Descriptors: behavior, flight distance principle, human-animal bond, mutual confidence.

Crowell-Davis, S.L. (1992). **The effect of the researcher on the behavior of horses.** In: *The Inevitable Bond: Examining Scientist-Animal Interactions* H. Davis and D. Balfour, eds., Cambridge University Press: Cambridge, England, pp. 316-333.
NAL call number: QL55 I44
Descriptors: flight distance, avoidance, feral horses, domestic horses, psychobiology, researcher personality.

Crowell-Davis, S.L, K.A. Houpt, and C.M. Carini (May 1986). **Mutual grooming and nearest-neighbor relationships among foals of *Equus caballus*.** *Applied Animal Behaviour Science* 15(2):113-123.
NAL call number: QL750.A6
Descriptors: behavior, social interaction, herd structure, sex differences.

Crowell-Davis, S.L., K.A. Houpt, and L. Kane (August 1987). **Play development in Welsh pony (*Equus caballus*) foals.** *Applied Animal Behaviour Science* 18(2):119-131.
NAL call number: QL750.A6
Descriptors: behavior, colt, fillies, mating behavior, mares.

Cuddeford, D. and P. Imlah (1991). **Effect of restricted grazing area on the normal behaviour of horses.** *Applied Animal Behaviour Science* 30(1-2):192(abstract).
NAL call number: QL750.A6
Descriptors: welfare, behavior, grazing, natural environment.

Ewbank, R. (January 1985). **Contributions of ethology to clinical interpretation of the horse's welfare.** *Equine Veterinary Journal* 17(1):2-3.
NAL call number: SF955.E6
Descriptors: behavior, welfare, care, health, handling, well-being.

Fagen, R.M. and T.K. George (1977). **Play behavior and exercise in young ponies.** *Behavioral Ecology and Sociobiology* 2(3):267-269.
NAL call number: QL751 B4
Descriptors: foals, behavior, running, exercise, socialization.

Feh, C. and J. de Mazieres (1993). **Grooming at a preferred site reduces heart rate in horses.** *Animal Behaviour* 46(6):1191-1194.
NAL call number: 410 B77
Descriptors: social behavior, husbandry, grooming, stress.

Heird, J.C., R.W. Bell, and S.G. Brasier (1986/1987). **Effects of early experience upon adaptiveness of horses.** In: *Advances in Animal Welfare Sciences* Martinus Nijhoff Publishers: Boston, MA, pp.103-109.
NAL call number: HV4701.A34
Descriptors: foals, adaptability, domestication, behavior, welfare, training.

Heird, J.C., D.D. Whitaker, R.W. Bell, C.B. Ramsey, and C.E. Lokey (1986). **The effects of handling at different ages on the subsequent learning ability of 2-year-old horses.** *Applied Animal Behaviour Science* 15(1):15-25.
NAL call number: QL750.A6
Descriptors: behavior, learning, training, novel stimuli, conditioning, maze-learning.

Hogan, E.A., K.A. Houpt, and K. Sweeney (September 1988). **The effect of enclosure size on social interactions and daily activity patterns of the captive Asiatic wild horse (*Equus przewalskii*).** *Applied Animal Behaviour Science* 21(1/2):147-168.
NAL call number: QL750.A6
Descriptors: *Equus caballus przewalskii*, wild animals, housing, space requirements, socialization, behavior.

Houpt, K.A. (Winter 1987). **Equine behavior problems in relation to humane care.** *Anthrozoos* 1(3):184-187.
NAL call number: SF411.A57
Descriptors: aggression, behavior, handling, care, treatment, welfare.

Houpt, K.A. and H.F. Hintz (1983). **Some effects of maternal deprivation on maintenance behavior, spatial relationships and responses to environmental novelty in foals.** *Applied Animal Ethology* 9(3/4):221-230.
NAL call number: QL750 A6
Descriptors: social behavior, feeding behavior, stress, newborn, foals, solitary confinement, pasture, familiarity, contact, space, grazing, novel environment.

Houpt, K.A. and T.R. Houpt (June 1992). **Social and illumination preferences of mares.** *Equine Practice* 14(6):11-16.
NAL call number: SF951.E62
Descriptors: social environment, physical environment, operant conditioning, lighting, preferences, behavior.

Houpt, K.A. and T.R. Houpt (September 1988). **Social and illumination preferences of mares.** *Journal of Animal Sciences* 66(9):2159-2164.
NAL call number: 49.J82
Descriptors: social environment, physical environment, operant conditioning, lighting, preferences, behavior.

Hunter, L. and K.A. Houpt (August 1989). **Bedding material preferences of ponies.** *Journal of Animal Sciences* 67(8):1986-1991.
NAL call number: 49 J82
Descriptors: housing, behavior, substrate, straw, wood shavings.

Kiley-Worthington, M. (January 1990). **The behaviour of horses in relation to management and training, towards ethologically sound environments.** *Journal of Equine Veterinary Science* 10(1):62-71.
NAL call number: SF951.J65
Descriptors: behavioral problems, vices, feeding behavior, mating behavior, group interaction, tractability, animal welfare, time allocation.

Kiley-Worthington, M. (1987). ***The behaviour of horses in relation to management and training: Horse psychology and behavior*** A. Muller: Ruschlikon-Zurich, Switzerland, 216p.
NAL call number: SF281.K5415 (German), SF281.K54 (English)
Descriptors: welfare, social behavior, learning, stereotypies.

Kolter, L. (September 1988). **Social behavior of Przewalski horses in the Cologne Zoo and its consequences for management and housing.** *Applied Animal Behaviour Science* 21(1/2):117-145.
NAL call number: QL750.A6
Descriptors: *Equus caballus przewalskii*, social behavior, housing, husbandry, facilities, zoological gardens, space requirements.

Kolter, L. (1984). **Social relationships between horses and its influence on feeding activity in loose housing.** In: *Proceedings of the International Congress on Applied Ethology in Farm Animals* J. Unshelm, G. van Putten and K. Zeeb, eds., Germany, pp. 151-155.
NAL call number: SF756.7.I5
Descriptors: social behavior, feeding behavior, housing, space, size.

Kresse, W. (1993). **Open housing for the welfare of horses [Offenstllhaltung fuers wohlbefinden der pferde.]** *Landwirtschaftliches Wochenblatt. Organ des Landesbauernverbandes in Baden-Wuerrtemberg* 160(8):45(abstract).
NAL call number: S232 B24L36
Descriptors: saddle horses, housing, animal needs, livestock, work animals, preferences.

Kusunose, R., H. Hatakeyama, F. Ichikawa, K. Kubo, A. Kiguchi, Y. Asai, and K. Ito (1986). **Behavioral studies on yearling horses in field environments. 2.Effects of group size on the behaviour of horses.** In: *Bulletin of Equine Research Institute (No. 23)* Equine Research Institute, Japan Racing Association: Tokyo, Japan, pp.1-6.
NAL call number: SF321 N5
Descriptors: animal behavior, group dynamics, social behavior, pastured, grazing.

Kusunose, R., H. Hatakeyama, K. Kubo, A. Kiguchi, Y. Asai, Y. Fujii, and K. Ito (1985).**Behavioral studies on yearling horses in field environments. I. Effects of the field size on the behavior of horses.** In: *Bulletin of Equine Research Institute (No. 22)* Equine Research Institute, Japan Racing Association: Tokyo, Japan, pp.1-7.
NAL call number: SF321 N5
Descriptors: animal behavior, group dynamics, social behavior, exercise, field size, pastured, grazing.

Mal, M.E., T.H. Friend, D.C. Lay, S.G. Vogelsang, and O.C. Jenkins (July 1991). **Behavioral responses of mares to short-term confinement and social isolation.** *Applied Animal Behaviour Science* 31(1/2):13-24.
NAL call number: QL750.A6
Descriptors: behavior, isolation, socialization, pastures, open housing, stalls, stress.

Mal, M.E., T.H. Friend, D.C. Lay, S.G. Vogelsang, and O.C. Jenkins (1991). **Physiological responses of mares to short-term confinement and social isolation.** *Journal of Equine Veterinary Science* 11(2):96-102.
NAL call number: SF951.J65
Descriptors: isolation, stalls, cortisol, stress, disease, adrenal glands, haemoglobin, thyroid hormones, mitogens, lymphocyte transformation, environment, housing, haematology, immune response, age differences.

Mal, M.E., C.A. McCall, K.A. Cummins, and C. Newland (1992). **Influence of early handling on subsequent learning abilities in weanling horses.** *Journal of Animal Science* 70 (Supplement 1):156(abstract).
NAL call number: 49 J82
Descriptors: abstract, foal, behavior, care, management, livestock, stress.

Malinowski, K., N.A. Hallquist, L. Helyar, A.R. Sherman, and C.G. Scanes (September 1990). **Effect of different separation protocols between mares and foals on plasma cortisol and cell-mediated immune response.** *Journal of Equine Veterinary Science* 10(5):363-368.
NAL call number: SF951.J65
Descriptors: weaning, stress, hydrocortisone, concentration, immunity, behavior, blood plasma, separation.

Malpass, J.P. (November 1994). **A simple and effective environmental enrichment device for ponies in long-term indoor confinement.** *Contemporary Topics in Laboratory Animal Science* 33 (6):74-76.
NAL call number: SF405.5.A23
Descriptors: horses, environment, enrichment, foraging, abnormal behavior.

McCall, C.A. (1993). **Solving behavior problems in horses.** *Equine Practice* 15(8):30-31.
NAL call number: SF951.E62
Descriptors: disease, animal behavior, animal welfare, housing, feeding exercise, training, abnormal behavior, stimuli, positive reinforcement, learning.

McCall, C.A. (January 1990). **A review of learning behavior in horses and its application in horse training.** *Journal of Animal Science* 68(19):75-81.
NAL call number: 49.J82
Descriptors: learning ability, training.

McCall, J. (1988). ***Influencing horse behavior a natural approach to training, 1st edition.*** Alpine Publishers: Loveland, CO, 77p.
NAL call number: SF287.M44
Descriptors: behavioral principles, psychology, handling, care.

McCann, J.S. (1986). **Ethological observations and the effect of handling and reserpine on normal and nervous yearling horses.** *Dissertation Abstracts International, B* 47(2):446.
NAL call number: Z5055 U49D53
Descriptors: theses, adaptation, training, behavior, stress, neuroleptics.

Pinsent, P.J.N. (1984). **The horse and its welfare in different states of confinement.** In: *Priorities in Animal Welfare: The Proceedings of the Animal Welfare Foundation's First Symposium* L. Bagnall, ed., BVA Animal Welfare Foundation: London, England, pp.67-72.
NAL call number: HV4704.A54
Descriptors: environment, stress, welfare, sports, isolation, space, socialization.

Pollack, J. (March 1987). **Welfare lessons of equine social behavior.** *Equine Veterinary Journal* 19(2):86-89.
NAL call number: SF955.E6
Descriptors: social behavior, wild horses, wild burros, social structure.

Rifa, H. (January 1990). **Social facilitation in the horse.** *Applied Animal Behaviour Science* 25(1/2):167-176.
NAL call number: QL750.A6
Descriptors: *Equus caballus*, maternal behavior, social behavior.

Smith, C.P. (1994). ***Housing, Husbandry, and Welfare of Horses: January 1988-January 1994.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 62p.
NAL call number: aZ5071.N3 no.94-22
Descriptors: bibliography, flooring, stress, housing design, ventilation, temperature control, transport, social environment.

Tellington-Jones, L. (1994). ***A Touch of Magic for Horses*** Phane Marketing International, Inc.: La Quinta, CA, VHS, 47 minutes.
Descriptors: training, handling, stress, human-animal bond, learning, total body recognition, vices..

Tellington-Jones, L. and U. Bruns (1988). ***An Introduction to the Tellington-Jones Equine Awareness Method: The T.E.A.M. Approach to Problem-free Training***
Breakthrough Publications: Millwood, NY, 180p.
NAL call number: GV1831 H8T44
Descriptors: handling, total body awareness, human-animal bond, learning.

Williams, M. (1974). **The effect of artificial rearing on the social behavior of foals.** *Equine Veterinary Journal* 6(1):17-18.
NAL call number: SF955.E6
Descriptors: intensive husbandry, foal, social behavior.

Young, J.R. (July 1979). **Man and horse vs. boredom.** *Horseman* 23(12):22-23, 26-27.
NAL call number: SF309.H6
Descriptors: repetition, training, handling, varied routine.

Zeeb, K. (March 1994). **Possibilities for the all-year raising of horses. [Moglichkeiten der ganzjahrigen freilandhaltung von pferden.]** *Deutsche Tierärztliche Wochenschrift* 101(3):122-123.
NAL call number: 41.8 D482
Descriptors: animal needs, welfare, management, semi-natural environment, shelter, social behavior, comfort behavior.

Zeitlerfeicht, M.H. (May 1993). **Minimum requirements for lighting, climate and air-pollution for horse stables with respect to animal welfare.** *Tierärztliche Umschau* 48(5):311.
NAL call number: 41.8 T445
Descriptors: stables, animal health, metabolic changes, humidity, environment, temperature, ammonia concentrations.

SHEEP AND GOATS

Baldock, N.M. and R.M. Sibly (November 1990). **Effects of handling and transportation on the heart rate and behaviour of sheep.** *Applied Animal Behaviour Science* 28(1/2):15-39.
NAL call number: QL750.A6
Descriptors: isolation, handling, transport, stress, heart rate.

Berry, D. (1994). ***Housing, Husbandry, and Welfare of Sheep and Goats: January 1985-April 1994.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 30p.
NAL call number: aZ5071.N3 no.94-36
Descriptors: bibliography, flooring, crate design, ventilation, temperature control.

Biquand, S. and V. Biquand-Guyot (1992). **The influence of peers, lineage and environment on food selection of the criollo goat (*Capra hircus*).** *Applied Animal Behaviour Science* 34(3):231-245.
NAL call number: QL750 A6
Descriptors: social environment, food selection, genetics.

Bobek, S., J. Niezgoda, K. Pierzchala, P. Litynski, and A. Sechman (November 1986). **Changes in circulating levels of iodothyronines, cortisol and endogenous thiocyanate in sheep during emotional stress caused by isolation of the animals from the flock.** *Zentralblatt fürVeterinarmedizin, Riehe A* 33(9):698-705.
NAL call number: 41.8 Z5
Descriptors: social isolation, stress, adaptation, physiology.

Boe, K., J.J. Nedkvitne, and D. Austbo (December 1991). **The effect of different housing regimes on the performance and rectal temperature of sheep.** *Animal Production* 53(pt. 3):332-337.
NAL call number: 49 AN55
Descriptors: housing, environmental temperature, feed intake, production.

Carbonaro, D.A., T.H. Friend, G.R. Dellmeier, and L.C. Nuti (February 1992). **Behavioral and physiological responses of dairy goats to isolation.** *Physiology and Behavior* 51(2):297-301.
NAL call number: QP1 P4
Descriptors: Nubian goat, Alpine goat, social isolation, fear, vocalization, behavior.

Casteilla, L., P. Orgeur, and J.P. Signoret (December 1987). **Effects of rearing conditions on sexual performance in the ram: Practical use.** *Applied Animal Behaviour Science* 19(1/2):111-118.
NAL call number: QL750.A6
Descriptors: social behavior, experience, sexual behavior, rams.

Fenwick, D.C. and D.J. Green (August 1986). **The effects of handling procedures, breed differences and treatment with lithium and dexamethasone on some blood parameters in sheep.** *Applied Animal Behaviour Science* 16(1):39-47.
NAL call number: QL750.A6
Descriptors: ewes, border leicester, blood plasma, erythrocytes, sodium, potassium, calcium, hypocalcemia, stress, behavior.

Gonyou, H.W. (October 1991). **Behavioral methods to answer questions about sheep.** *Journal of Animal Science* 69(10):4155-4160.
NAL call number: 49 J82
Descriptors: preference testing, aversiveness, spatial behavior, social behavior.

Gonyou, H.W. and J.M. Stookey (July 1985). **Behavior of parturient ewes in group-lambing pens with and without cubicles.** *Applied Animal Behaviour Science* 14(2):163-171.
NAL call number: QL750.A6
Descriptors: goats, parturition, cubicles, kids, pens.

Gonyou, H.W., J.M. Stookey, and L.G. McNeal (May 1985). **Effects of double decking and space allowances on the performance and behavior of feeder lambs.** *Journal of Animal Science* 60(5):1110-1116.
NAL call number: 49 J82
Descriptors: production, growth, behavior, housing.

Gordon, G.D.H. and M.S. Cockram (May 1995). **A comparison of wooden slats and straw bedding on the behaviour of sheep.** *Animal Welfare* 4(2): 131-134.
NAL call number: HV4701 A557
Descriptors: standing, moving, lying, flooring preference.

Hargreaves, A.L. and G.D. Hutson (May 1990). **The effect of gentling on heart rate, flight distance and aversion of sheep to a handling procedure.** *Applied Animal Behaviour Science* 26(3):243-252.
NAL call number: QL750.A6
Descriptors: handling, fear, heart rate, stress.

Hemsworth, P.H., J.L. Barnett, and G.J. Coleman (1993). **The human-animal relationship in agriculture and its consequences for the animal.** *Animal Welfare* 2(1):33-51.
NAL call number: HV4701.A557
Descriptors: stockpeople, human-animal bond, fear, handling.

Hinch, G.N. (1994). **The behavioural and physiological assessment of well-being, pain, and distress in sheep and cattle.** In: *Improving the Well-being of Animals in the Research Environment: Proceedings of the conference held at the Marriott Hotel, Sydney, October, 1993* R.M. Baker, G. Jenkin, and D.J. Mellor, eds., ANZCCART, P.O. Box 19, Glen Osmond, SA, 5064, Australia, pp. 35-40.
Descriptors: stress, pain, social behavior, physiology, stereotypies.

Horton, G.M.J., K. Malinowski, C.C. Burgher, and D.D. Palatini (November 1991). **The effect of space allowance and sex on blood catecholamines and cortisol, feed consumption, and average daily gain in growing lambs.** *Applied Animal Behaviour Science* 32(2/3):197-204.
NAL call number: QL750.A6
Descriptors: space, housing, growth, stress, physiology, lambs.

Lawrence, A.B. and D.G.M. Wood-Gush (1985). **Investigations on social space in open and restricted environments in sheep.** *Current Topics in Veterinary Medicine and Animal Science* 35:171-191.
NAL call number: SF600.C82
Descriptors: space, social behavior, loose housing, clustering.

Lyons, D.M. (1992). **Early human-animal relationships and temperament differences among domestic dairy goats.** In: *The Inevitable Bond: Examining Scientist-Animal Interactions* H. Davis and D. Balfour, eds., Cambridge University Press: Cambridge, England, pp. 295-315.
NAL call number: QL55 I44
Descriptors: flight distance, avoidance, rearing experience, corticosteroids, production, psychobiology.

Lyons, D.M. and E.O. Price (1987). **Relationships between heart rates and behavior of goats in encounters with people.** *Applied Animal Behaviour Science* 18(3-4):363-370.
NAL call number: QL750.A6
Descriptors: fear, heart rate, vocalizations, human-animal bond.

Lyons, D.M., E.O. Price, and G.P. Moberg (July 1993). **Social grouping tendencies and separation-induced distress in juvenile sheep and goats.** *Developmental Psychobiology* 26(5):251-259.
NAL call number: QP351 D4
Descriptors: social affinities, pen-mates, locomotor activity, plasma corticosteroid, vocalizations, adrenocortical responses, natural grouping, object attachment, depression, psychology, socialization, stress.

Lyons, D.M., E.O. Price, and G.P. Moberg (1988). **Individual differences in temperament of domestic dairy goats: Constancy and change.** *Animal Behaviour* 36(5):1323-1333.
NAL call number: 410 B77
Descriptors: genetics, rearing environment, social behavior, temperament.

Mateo, J.M., D.Q. Estep, and J.S. McCann (October 1991). **Effects of differential handling on the behaviour of domestic ewes (*Ovis aries*).** *Applied Animal Behaviour Science* 32(1):45-54.
NAL call number: QL750.A6
Descriptors: handling, lambs, human-animal bond.

Moberg, G.P. and V.A. Wood (1985). **Effect of differential rearing on the behavioral and adrenalcortical response of lambs to a novel environment.** *Developments in Animal and Veterinary Sciences* 18:403-413.
NAL call number: QL1.D48
Descriptors: housing, stress physiology, rearing, lambs.

Niezgoda, J., D. Wronska, K. Pierzchala, S. Bobek, and S. Kahl (December 1987). **Lack of adaptation to repeated emotional stress evoked by isolation of sheep from the flock.** *Zentralblatt für Veterinarmedizin, Reihe A* 34(10):734-739.
NAL call number: 41.8 Z5
Descriptors: social isolation, stress, adaptation, physiology.

Nugent, R.A. III and T.G. Jenkins (August 1992). **Effects of alternative lamb production systems, maternal line, and culling strategy on flock age structure.** *Journal of Animal Science* 70(8):2285-2295.
NAL call number: 49 J82
Descriptors: production, lambing, age, ewe replacement.

Parrott, R.F., K.A. Houpt, and B.H. Misson (May 1988). **Modification of the responses of sheep to isolation stress by the use of mirror panels.** *Applied Animal Behaviour Science* 19(3/4):331-338.
NAL call number: QL750.A6
Descriptors: cortisol, isolation, stress, mirrors.

Ramos, A. and T. Tennessen (March 1992). **Effect of previous grazing experience on the grazing behavior of lambs.** *Applied Animal Behaviour Science* 33(1):43-52.
NAL call number: QL750.A6
Descriptors: feeding preferences, age, genetics, experience.

Scheibe, K.M. (1989). **Experimental determination of stress situations of sheep locomotor and psychic challenge in the course of keeping.** *Monatshefte für Veterinaermedizin* 44(13):450-453.
NAL call number: 41.8 M742
Descriptors: handling, isolation, noise, stress.

Wood, G.N., V. Molony, S.M. Fleetwood-Walker, J.C. Hodgson, and D.J. Mellor (1991). **Effects of local anaesthesia and intravenous naloxone on the changes in behaviour and plasma concentrations of cortisol produced by castration and tail docking with tight rubber rings in young lambs.** *Research in Veterinary Science* 51(2):193-199.
NAL call number: 41.8 R312
Descriptors: lambs, castration, docking, hydrocortisone, lidocaine, naloxone, behavior, blood plasma, pain, anesthesia.

SWINE

Algers, B. and P. Jensen (1985). **Communication during suckling in the domestic pig. Effects of continuous noise**. *Applied Animal Behaviour Science* 14:49-61.
NAL call number: QL750.A6
Descriptors: background noise, vocalizations, litter size, milk production.

Allen, T. (March 1994). ***Housing, husbandry, and welfare of swine: January 1991-January 1994***. *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 75p.
NAL call number: aZ5071.N3 no.94-14
Descriptors: bibliography, housing, flooring, pens, ventilation, temperature control, behavior, enrichment.

Anon. (May 1991). **Sow stall and tethers**. *Veterinary Record* 128(18):431-432.
NAL call number: SF601 I4
Descriptors: restraint, pregnancy, husbandry, welfare.

Apple, J.K. and J.V. Craig (November 1992). **The influence of pen size on toy preference of growing pigs**. *Applied Animal Behaviour Science* 35(2):149-155.
NAL call number: QL750.A6
Descriptors: housing, stocking density, play, stress, abnormal behavior.

Appleby, M.C. and D.G.M. Wood-Gush (June 1985). **Welfare of piglets in flat-deck cages**. *Animal Production* 40(5):548.
NAL call number: 49 AN55
Descriptors: earth substrate, bare floor, flat-deck cages.

Arellano, P.E., C. Pijoan, L.D. Jacobson, and B. Algers (1992). **Stereotyped behaviour, social interactions, and suckling pattern of pigs housed in groups or in single crates**. *Applied Animal Behaviour Science* 35(2):157-166.
NAL call number: QL750.A6
Descriptors: housing, suckling behavior, crates, abnormal behavior, pens, chewing, aggression, straw, and space.

Arey, D.S. (1993). **Effect of straw on the behaviour and performance of growing pigs in "Straw-Flow" pens**. *Farm Building Progress* No. 112:24-25.
NAL call number: TH4911 F37
Descriptors: litter, pens, housing, behavior, comparison, self-dispensing, manual dispensing, natural behaviors, foraging, exploration, activity.

Arey, D.S. (1993). **The effect of straw on the behaviour and performance of growing pigs kept in a novel housing system.** In: *Livestock Environment IV: Fourth International Symposium, University of Warwick, Coventry, England, July 6-9, 1993* E. Collins and C. Boon, eds., Scottish Agricultural College, Centre for Rural Building, Craibstone, Bucksburn, Aberdeen AB2 9TR, UK, pp.491-494.
NAL call number: SF91 L58
Descriptors: swine, litter, behavior, Straw-Flow, performance, feed conversion, behavioral effects, substate.

Arey, D.S. (1993). **The welfare of pigs in confined and non-confined farrowing systems.** *Pig News and Information* 14(2):81N-84N.
NAL call number: SF391 P55
Descriptors: reviews, sows, parturition, piglets, housing, farrowing, environment.

Arey, D.S. (1993). **The effect of bedding on the behaviour and welfare of pigs.** *Animal Welfare* 2(3):235-246.
NAL call number: HV4701 A557
Descriptors: reviews, straw, housing, behavior, litter, nesting.

Arey, D.S. (1993). **The preference of growing pigs for sloped or level floors.** *Farm Building Progress* No. 114:18-20.
NAL call number: TH4911 F37
Descriptors: lying activity, feeding activity, behavior, housing.

Arey, D.S., and J.M. Bruce (April 1993). **A note on the behaviour and performance of growing pigs provided with straw in a novel housing system.** *Animal Production* 56(pt.2):269-272.
NAL call number: 49 An55
Descriptors: swine, behavior, substrate, bedding, growth rate, feed conversion effiiciency, welfare, husbandry.

Arey, D.S., J.M. Bruce, and C.A. Pearce (April 1993). **Straw-flow: A high welfare system for pigs.** In: *Proceedings from the Conference on Straw - A Valuable Raw Material* Pira International Publishing: Leatherhead, Surrey, UK, 4pp.
Descriptors: housing, litter, straw, self-dispensing, manipulation, bedding, sloped pens, behavior.

Arey, D.S., A.M. Petchey, and V.R. Fowler (1992). **The effect of straw on farrowing site choice and nest building behaviour in sows.** *Applied Animal Behaviour Science* 54:129-133.
NAL call number: QL750.A6
Descriptors: preference, lying, nesting behavior, farrowing, straw.

Arey, D.S., A.M. Petchey, and V.R. Fowler (1991). **The preparturient behaviour of sows in enriched pens and the effect of pre-formed nests.** *Applied Animal Behaviour Science* 31:61-68.
NAL call number: QL750.A6
Descriptors: nest building, sand floor, straw enrichment, motivation.

Baldwin, B.A. and I.B. Start (1985). **Illumination preferences of pigs.** *Applied Animal Behaviour Science* 14:233-243.
NAL call number: QL750.A6
Descriptors: preference testing, light, motivation, environmental control.

Baldwin, B.A. and G.B. Meese (May 1977). **Sensory reinforcement and illumination preference in the domesticated pig.** *Animal Behaviour* 25(2):497-507.
NAL call number: 410 B77
Descriptors: light, heat preference, reinforcement, environmental control.

Barnett J.L., G.M. Cronin, P.H. Hemsworth, and C.G. Winfield (1983). **The welfare of confined sows: physiological, behavioral, and production responses to contrasting housing systems and handler attitudes.** *Annals of Veterinary Research [Annales de Recherches Veterinarires]* 15(2):217-226.
NAL call number: SF602 A5
Descriptors: human-animal interaction, corticosteroid level, stress, handling.

Barnett, J.L. and P.H. Hemsworth (1994). **The animal's response to its physical environment-physiology and behavior.** In: *Improving the Well-being of Animals in the Research Environment: Proceedings of the conference held at the Marriott Hotel, Sydney, October, 1993* R.M. Baker, G. Jenkin, and D.J. Mellor, eds., ANZCCART, P.O. Box 19, Glen Osmond, SA, 5064, Australia, pp. 65-73.
Descriptors: group housing, pen shape, stress, tether-stall, density, aggression.

Barnett, J.L., and P.H. Hemsworth (August 1986). **The impact of handling and environmental factors on the stress response and its consequences in swine.** *Laboratory Animal Science* 36(4):366-369.
NAL call number: 410.9 P94
Descriptors: swine, handling, environment, stress, housing, behavior.

Barnett J.L., P.H. Hemsworth, G.M. Cronin, E.A. Newman, T.H. McCallum, and D. Chilton (1992). **Effects of pen size, partial stalls, and method of feeding on welfare-related behavioural and physiological responses of group-housed pigs.** *Applied Animal Behaviour Science* 34(3):207-220.
NAL call number: QL750.A6
Descriptors: swine, cortisol, pen design, skin lesion, aggression, stress response, pregnancy statistics.

Barnett J.L., P.H. Hemsworth, G.M. Cronin, C.G. Winfield, T.H. McCallum, and E.A. Newman (1988). **The effects of genotype on physiological and behavioral responses related to the welfare of pregnant pigs.** *Applied Animal Behaviour Science* 20(3-4):287-296.
NAL call number: QL750.A6
Descriptors: social interaction, tethering vs. groups, growth, stall-design, pregnancy, stress, aggression.

Barnett, J.L., P.H. Hemsworth, E.A. Newman, T.H. McCallum, and C.G. Winfield (1989). **The effect of design of tether and stall housing on some behavioral and physiological responses related to the welfare of pregnant pigs.** *Applied Animal Behaviour Science* 24(1):1-12.
NAL call number: QL750.A6
Descriptors: swine, social interaction, stress, corticosteroid, group-house, tether-stalls, cage-stalls, pen design.

Barnett J.L., P.H. Hemsworth, and C.G. Winfield (1987). **The effects of design of individual stalls on the social behavior and physiological responses related to the welfare of pregnant pigs.** *Applied Animal Behaviour Science* 18(2):133-142.
NAL call number: QL750.A6
Descriptors: swine, chronic stress, aggression, stall-design, welfare, free-corticosteroid.

Barnett, J.L. and G.D. Hutson (1987). **Objective assessment of welfare in the pig: Contributions from physiology and behavior.** In: *Manipulating Pig Production I. Proceedings of the Inaugural Conference of the Australasian Pig Science Association (APSA)* J.L. Barnett, E.S. Batterham, G.M. Cronin, C. Hansen, P.H. Hemsworth, D.P Hennessy, P.E Hughes, N.E. Johnston, and R.H. King, eds., Australasian Pig Science Association: Werribee, Australia, pp. 1-22.
NAL call number: SF391.3 A87
Descriptors: swine, environment, stress, welfare, behavior, physiology, review.

Barbari, M., U. Chiappini, and P. Rossi (1993). **Survey on the behaviour of pregnant sows housed in collective pen with straw bedding.** In: *Livestock Environment IV: Fourth International Symposium, University of Warwick, Coventry, England, July 6-9, 1993,* E. Collins and C. Boon, eds., Scottish Agricultural College, Centre for Rural Building, Craibstone, Bucksburn, Aberdeen AB2 9TR, UK, pp.453-460.
NAL call number: SF91 L58
Descriptors: swine, behavior, housing, litter, nesting, slatted floors, flooring, groups, comparison, individual stalls, group housing.

Bartussek, H., R. Steinwender, A. Hausleitner, A. Schauer, and J. Solkner (1993). **Influence of keeping restricted fed pigs in groups without or with straw litter at different ambient temperatures on daily gain, feed conversion and carcass quality [Zum Einfluss der gruppenhaltung mit und ohne stroheinstreu bei unterschiedlichen schlachtkorperqualitat von restriktiv gefutterten mastschweinen.]** *Die Bodenkultur* 44(2):163-182.
NAL call number: 19 B635
Descriptors: welfare, feed conversion, environment, housing, restricted feeding, flooring, injuries.

Batchelor, G.R. (1991). **Environmental enrichment for the laboratory pig.** *Animal Technology: Journal of the Institute of Animal Technology* 42(3):185-189.
NAL call number: QL55.I5
Descriptors: toys, social interaction, human-animal bond.

Beattie, V.E., I.A. Sneddon, and N. Walker (1993). **Effect of environmental enrichment on behaviour, growth, and meat quality in the domestic pig *Sus scrofa*.** *Animal Production* 56(3):477(abstract).
NAL call number: SF19.C45
Descriptors: abstract, behavior, husbandry, environment, housing, substrate, straw.

Beattie, V.E., I.A. Sneddon, and N. Walker (1993). **Behaviour and productivity of the domestic pig in barren and enriched environments.** In: *Livestock Environment IV: Fourth International Symposium, University of Warwick, Coventry, England, July 6-9, 1993,* E. Collins and C. Boon, eds., American Society of Agricultural Engineers: St. Joseph, MI, pp.43-50.
NAL call number: SF91 L58
Descriptors: swine, behavior, housing, litter, stress, exploratory behavior, comparison, individual stalls, group housing, behavioral effects, growth rates.

Beattie, V.E., N. Walker, and I.A. Sneddon (1995). **Effects of** environmental enrichment on behaviour and productivity of growing pigs. *Animal Welfare* 4:207-220.
NAL call number: HV4701 A557
Descriptors: animal welfare, behaviour, environmental enrichment, intensive housing, tail biting, growth rates, substrate, barren pens.

Beattie, V.E., N. Walker, and I.A. Sneddon (1993). **Effects of space allowance and environmental enrichment for the domestic pig (*Sus scrofa*).** *Applied Animal Behaviour Science* 38(1):82.
NAL call number: QL750.A6
Descriptors: housing, welfare, behavior, bedding, socialization.

Becker, B.A., J.J. Ford, J.A. Nienaber, G.L. Hahn, and R.K. Christenson (1986). **Endocrine and behaviour changes associated with intensive housing systems for swine.** In: *Swine in Biomedical Research* M.E. Tumbleson (ed.), Vol. 1. Plenum Press: New York, pp. 173-189.
NAL call number: RB125.C68 1985.
Descriptors: gilts, sows, behavior, pig housing, intensive husbandry, tether stalls, ACTH, cortisol, dexamethasone.

Blackburn, P.W. (March 1991). **Ban on sow stalls and tethers**. [Letter] *Veterinary Record* 128(6):140.
NAL call number: SF601 I4
Descriptors: stalls, tether, housing, welfare.

Britton, M., J.A. Roden, O. MacPherson, G. Willox, and P.R. English (1993). **A comparison of a straw-based and slatted floor housing system for the weaned pig.** *Animal Production* 56(3):477(abstract).
NAL call number: SF19.C45
Descriptors: abstract, swine, welfare, housing, litter, injuries, weight gain.

Carter, H. (February 1991). **Ban on sow stalls and tethers**. [Letter] *Veterinary Record* 128(6):140.
NAL call number: SF601 I4
Descriptors: stalls, tether, housing, welfare.

Chiappini, U. (April 1993). **The "peace" of sows on the straw [La "tranquillita" delle scrofe su paglia.]** *Rivista di Suinicoltura* 34(4):89-92.
NAL call number: 46.8 Su3
Descriptors: welfare, behavior, reproduction, pregnancy, intensive husbandry, farrowing pens, litter, bedding.

Cronin, G.M., P.R. Wiepkema, and J.M. Van Ree (1986). **Endorphins implicated in stereotypies of tethered sows**. *Experientia* 42:198-199.
NAL call number: 475 EX7
Descriptors: coping, tether, stereotypies, endorphins, chronic stress.

Dantzer, R., H.W. Gonyou, S.E. Curtis, and K.W. Kelley (1987). **Changes in serum cortisol reveal functional differences in frustration-induced chain chewing in pigs**. *Physiology and Behavior* 39(6):775-777.
NAL call number: QP1.P4
Descriptors: food presentation, stereotypies, cortisol.

Ernst, E., S. Stamer, and G. Gertken (1993). **Animal welfare in group housing of breeding sows [Tiergerechte gruppenhaltung bei zuchtsauen.]** *KTBL-Schrift* No. 357:131pp.
Descriptors: automatic feeding, natural behavior, individual housing, group housing, feed conversion.

Faucitano, L. (March 1993). **Less stress, more welfare: Swine breeding in the ECC [Meno stress, piu benessere: Allevamento suini nella CEE.]**
NAL call number: 46.8 Su3
Descriptors: swine, husbandry methods, animal health, intensive husbandry, meat yield, meat quality, European community.

Farmer, C. and G.I. Christison (1982). **Selection of perforated floors by newborn and weanling pigs**. *Canadian Journal of Animal Science* 62:1229-1236.
NAL call number: 41.8 C163
Descriptors: floor preferences, expanded metal, temperature, traction.

Feddes, J.J.R. and D. Fraser (1994). **Non-nutritive chewing by pigs: Implications for tail-biting and behavioral enrichment.** *Transactions of the ASAE (American Society of Agricultural Engineers)* 37(3):947-950.
NAL call number: 290.9 Am32T
Descriptors: pigs, juvenile, braided cotton cord, rubber strips, chewing, tail-biting.

Fiedler, E. (1993). **Straw and free range are good for sows. Stable-systems for piglet production [Stroh und auslauf tut sauen gut. Stallsysteme fuer die ferkelerzeugung.]** *Landwirtschaftliches Wochenblatt. Organ des Landesbauernverbandes in Baden-Wuerrtemberg* 160(39):18-19.
NAL call number: S232 B24L36
Descriptors: free range, housing, group size, straw.

Fisher, T.F. (May 1993). **Miniature swine in biomedical research: Applications and husbandry considerations.** *Lab Animal* 22(5):47-50.
NAL call number: QL55 A1L33
Descriptors: handling, social interactions, toys, psychological needs.

Franceschini, E. (1993). **Straw litter for the swine welfare [Lettiera di paglia per il benessere suino.** *Rivista di Suinicoltura* 34(2):41-43.
NAL call number: 46.8 Su3
Descriptors: straw, housing, husbandry, behavior, production.

Fraser, D., P.A. Phillips, B.K. Thompson, and T. Tennessen (1991). **Effect of straw on the behaviour of growing pigs.** *Applied Animal Behaviour Science* 30:307-318.
NAL call number: QL750 A6
Descriptors: behavior, raised decks, straw bedding, rooting, chewing, social activity.

Gertken, G. and E. Ernst (1993). **Integrated group housing: a form of keeping sows according to animal welfare [Integrierte Gruppenhaltung: eine tiergerechte Haltungsform fuer Sauen.]** *Deutsche Gefluegelwirtschaft und Schweineproduktion* 45(31):18-20.
Descriptors: slatted floors, feed dispensers, automation, group housing.

Glodek, P. (1986). **Breeding program and population standards of the Gottingen miniature swine.** In: *Swine in Biomedical Research* M.E. Tumbleson, (ed.), Vol. 1. Plenum Press: New York, pp. 23-37.
NAL call number: RB125.C68 1985.
Descriptors: Gottingen miniature swine, breeding, boars, sows, body weight, litter size.

Gloor, P. and C. Holzer-Dolf (October 1986). **Should gilt sows be housed alone or in groups? [Galtsauen einzeln oder in Gruppen?]** *Schweizer Archiv für Tierheilkunde* 128(10):535-547.
NAL call number: 41.8 SCH9
Descriptors: housing, social groups, isolation, standards.

Gonyou, H.W., R.P. Chapple, and G.R. Frank (1992). **Productivity time budgets and social aspects of eating in pigs penned in groups of five or individually.** *Applied Animal Behaviour Science* 34(4):291-301.
NAL call number: QL750.A6
Descriptors: swine, pens design, barrow, gilt, weight gain, feed intake, diurnal.

Gonyou, H.W., P.H. Hemsworth, and J.L. Barnett (1986). **Effects of frequent interactions with humans on growing pigs.** *Applied Animal Behaviour Science* 15(4):303-314.
NAL call number: QL750 A6
Descriptors: corticosteroids, chronic stress, reproductive effects, handling.

Grandin, T. (Winter 1989). **Environment and genetic effect on hog handling.** *American Society of Agricultural Engineers Papers* St. Joseph, Michigan, 7p. Paper #89-4514.
NAL call number: 290.9 AM32P
Descriptors: swine, hogs, housing, enriched environment, sensory restriction, excitability, transportation, temperament, husbandry, genetic effects, behavior.

Grandin, T., S.E. Curtis, and W.T. Greenough (1988). **Environmental enrichment for pigs: Differences in somatosensory cortical neurons and subsequent behaviour.** In *Proceedings of the VIth International Congress on Animal Hygiene* I. Ekesbo (ed.), Vol. 2, Skare, Sweden. June 14-17, 1988. pp.692-695.
NAL call number: SF757 R36 no.20-21
Descriptors: piglets, cortex, stimulation, environment, behavior.

Grandin, T., S.E. Curtis, and W.T.Greenough (1983). **Effects of rearing environment on the behavior of young pigs.** *Journal of Animal Science* 57(Supplement 1):137(abstract).
NAL call number: 49 J82
Descriptors: care, handling, piglets, adaptation, housing.

Grandin, T., S.E. Curtis, and I.A. Taylor (1987). **Toys, mingling, and driving reduce excitability in pigs.** *Journal of Animal Science* 65(Supplement 1):230-231.
NAL call number: 49 J82
Descriptors: stress, husbandry, fear, enrichment devices.

Grauvogl, A. (1994). **Pigs require bread and play.** *Schweinezucht und Schweinemast* 41(2):30-32.
Descriptors: pigs, play, toys, games, behavior, welfare, performance.

Haskell, M.J. and G.D. Hutson (1993). **The pre-farrowing behaviour of sows with access to straw and space for locomotion.** *Animal Production* 56(3):435(abstract).
NAL call number: SF19.C45
Descriptors: abstract, swine, welfare, housing, litter, nest building, breeding, piglets, movement.

Hemsworth, P.H. (1992). **The biological basis of animals responses to man.** *Animal Production* 54(3):458.
NAL call number: SF19.C45
Descriptors: swine, chronic stress, fear, welfare.

Hemsworth, P.H. and J.L. Barnett (1992). **The effects of early contact with humans on the subsequent level of fear of humans in pigs.** *Applied Animal Behaviour Science 35(1):83-90.*
NAL call number: QL750.A6
Descriptors: swine, early handling, behavioral response, patting, stroking, socialization.

Hemsworth, P.H. and J.L. Barnett (1991). **The effects of aversively handling pigs, either individually or in groups, on their behaviour, growth and corticosteroids.** *Applied Animal Behaviour Science 30(1/2):61-72.*
NAL call number: QL750.A6
Descriptors: swine, handling, behavior, stress, growth, reproduction, corticoids, groups, individuals.

Hemsworth, P.H., J.L. Barnett, and G.J. Coleman (1993). **The human-animal relationship in agriculture and its consequences for the animal.** *Animal Welfare* 2(1):33-51.
NAL call number: HV4701.A557
Descriptors: stock people, human-animal bond, fear, handling.

Hemsworth, P.H., J.L. Barnett, and G.J. Coleman (1992). **Fear of humans and its consequences for the domestic pig.** In: *The Inevitable Bond: Examining Scientist-Animal Interactions* H. Davis and D. Balfour, eds., Cambridge University Press: Cambridge, England, pp. 264-284.
NAL call number: QL55.I44
Descriptors: fear, experimenter influence, corticosteroids, production.

Hemsworth, P.H., J.L. Barnett, and C. Hansen (1986). **The influence of handling by humans on the behaviour, reproduction and corticosteroids of male and female pigs**. *Applied Animal Behaviour Science* 15:303-314.
NAL call number: QL750.A6
Descriptors: stress, handling, physiology, corticosteroids, behavior.

Hemsworth, P.H., J.L. Barnett, and C. Hansen (1987). **The influence of inconsistent handling by humans on the behavior, growth, and corticosteroids of young pigs**. *Applied Animal Behaviour Science* 17(3-4):245-252.
NAL call number: QL750.A6
Descriptors: swine, stress, welfare, reproductive status, breeding behavior.

Hemsworth, P.H., J.L. Barnett, C. Hansen, and H.W. Gonyou (1986). **Influence of early contact with humans on subsequent behavioural response of pigs to humans**. *Applied Animal Behaviour Science* 15(1):55-63.
NAL call number: QL750.A6
Descriptors: socialization, husbandry, handling, human-animal bond.

Hemsworth, P.H., J.L. Barnett, C. Hansen, and C.G. Winfield (1986). **Effects of social environment on welfare status and sexual behavior of female pigs II: Effects of space allowance**. *Applied Animal Behaviour Science* 16(3):259-268.
NAL call number: QL750.A6
Descriptors: swine, gilt, corticosteroid, mating, stress, crowding, behavior.

Hennessy, D.P. and P.N. Jackson (1987). **Relationship between adrenal responsiveness and growth rate**. In: *Manipulating Pig Production I. Proceedings of the Inaugural Conference of the Australasian Pig Science Association (APSA)* J.L. Barnett, E.S. Batterham, G.M. Cronin, C. Hansen, P.H. Hemsworth, D.P Hennessy, P.E Hughes, N.E. Johnston, and R.H. King, eds., Australasian Pig Science Association: Werribee, Australia, pp. 23.
NAL call number: SF391.3 A87
Descriptors: swine, environment, hydrocortisone, growth, stress, welfare, behavior.

Hesse, D. (1994). **Pig keeping on straw**. *Landtechnik* 48(10):506,541-544.
NAL call number: S675.L32
Descriptors: litter, building material, round bales, environment, housing, husbandry, piglets, costs, dietary supplement.

Horrell, I. (1992). **Effects of environmental enrichment on growing pigs.** *Animal Production* 54(3):483.
NAL call number: 49 AN55
Descriptors: behavioral needs, rooting, vertical chain, football, straw, tire, space requirements, weight gain.

Hunter, E., S.A. Edwards, and P.H. Simmins (1989). **Social activity and feeder use by a dynamic group of 40 sows using a sow-operated computerized feeder.** *Animal Production* 48(3):643-644.
NAL call number: 49 AN55
Descriptors: dominance, environmental control, sows.

Kamada, T., M. Kimata, and I. Notsuki (1993). **The effect of providing pigs with toy on the welfare and performance.** *Journal of Animal Science* 71(Supplement 1):115(abstract).
NAL call number: 49 J82
Descriptors: abstract, manipulanda, device, housing, well-being.

Kerr, S.G.C., D.G.M. Wood-Gush, H. Moser, and C.T. Whittemore (1988). **Enrichment of the production environment and the enhancement of welfare through the use of the Edinburgh family pen system of pig production**. *Research and Development in Agriculture* 5(3):171-186.
NAL call number: S539.5 R473
Descriptors: alternative housing, family pens, commercial viability, abnormal behavior, lactational oestrus.

Ladewig, J. and L. Matthews (1990). **Social contact requirements of domestic pigs assessed by behavioral demand functions.** *Current Topics in Veterinary Medicine and Animal Science*. 53:25-30.
NAL call number: SF600.C82
Descriptors: social interaction, psychological needs.

Lawrence, A.B., E.M.C. Terlouw, and A.W. Illius (1991). **Individual differences in behavioral responses of pigs exposed to nonsocial and social challenges.** *Applied Animal Behaviour Science* 30(1-2):73-86.
NAL call number: QL750.A6
Descriptors: gilts, handling, novel objects, group feeding, social behavior.

Lien, J. and Klopfer, F.D. (1978). **Some relations between stereotyped suckling in piglets and exploratory behaviour and discrimination reversal learning in adult swine.** *Applied Animal Ethology* 4:223-233.
NAL call number: QL750.A6
Descriptors: artificially fed, sow-fed piglets, exploration, learning.

Maier, P. (1993). **Studies on ontogeny of playing behaviour in young piglets kept in a modified STOLBA pig house [Untersuchungen zur ontogenese des speil-und sozialverhaltens juveniler hausschweine in einem modifizierten STOLBA-familienstall.]** *Wiener Tierärztliche Monatsschrift* 80(3):89-90.
NAL call number: 41.8 T345
Descriptors: thesis, piglets, sows, behavior, socialization, housing.

Matthews, L.R. and J. Ladewig (1994). **Environmental requirements of pigs measured by behavioural demand functions.** *Animal Behaviour* 47(3):713-719.
NAL call number: 410 B77
Descriptors: pig, male, isolation, social contact, feed, behavior.

Marx, D. (1990). **Observations on the new animal welfare legislation on the housing of pigs.** *Tierärztliche Umschau* 45(2):94-103.
NAL call number: 41.8 T445
Descriptors: floor type, spatial behavior, lighting, lying area, defecation area.

Marx, D. and H. Schuster (February 1986). **Ethological choice studies with early weaned piglets kept on flat decks. 4. Results of studies on the preference for type of floor, surface size and padding (straw) from the viewpoint of the animal and conclusions for the evaluation of flat deck rearing with reference to all results. [Ethologische Wahlversuche mit fruhabgesetzten wahrend der Flatdeckhaltung. 4. Mitteilung: Ergebnisse der Untersuchungen zür Rangfolge der Bodenart, der Flachengrosse und des Reizangebotes (Stroh) aus der Sicht des Tieres und Schlussfolgerungen für die Beurteilung der Flatdeckhaltung unter Berucksichtigung aller Ergebnisse.]** *Deutsche Tierärztliche Wochenschrift* 93(2):75-80.
NAL call number: 41.8 D482
Descriptors: social behavior, preference testing, floor type, substrate, weaning, floor space.

McGlone, J.J. (October 1991). **Techniques for evaluation and quantification of pig reproduction.** *Journal of Animal Science* 69(10):4146-4154.
NAL call number: 49 J82
Descriptors: literature review, social behavior, preference tests, behavioral frequency, animal care.

Mendl, M., D.M. Broom and A.J. Zanella (1993). **A long-term study of the effects of housing conditions on the welfare of domestic pigs.** *Animal Production* 56(3):440(abstract).
NAL call number: abstract, flooring, pens, stalls, groups, individual, stress, weight gain.

Meunier-Salaun, M.C. and R. Dantzer (December 1990). **Behaviour-environment relationships in pigs: Importance for the design of housing management systems in intensive husbandry.** *Pig News and Information.* 11(4):507-513.
NAL call number: SF391.P55
Descriptors: behavior, housing, husbandry, age differences, welfare.

Mews, A.R. (April 1991). **Ban on sow stalls and tethers.** *Veterinary Record* 128(10):239.
NAL call number: SF601 I4
Descriptors: stalls, tether, restraint, housing.

Moore, A.S., H.W. Gonyou, J.M. Stookey, D.G. McLaren (1994). **Effect of group composition and pen size on behaviour, productivity, and immune response of growing pigs.** *Applied Animal Behaviour Science* 40(1):13-30.
NAL call number: QL750.A6
Descriptors: pigs, socially reared, pen size, aggression, injuries, activity, performance, immune response.

Nicol, C.J. and S.J. Pope (1994). **Social learning in sibling pigs.** *Applied Animal Behaviour Science* 40(1):31-43.
NAL call number: QL750.A6
Descriptors: novel diet, learning, exploration, siblings.

Paterson, A.M. and G.P. Pearce (1992). **Growth, response to humans and corticosteroids in male pigs housed individually and subjected to pleasant, unpleasant or minimal handling during rearing.** *Applied Animal Behaviour Science* 34:315-328.
NAL call number: QL750.A6
Descriptors: aversive handling, effects, behavior, plasma cortisol, adrenal response, stress, growth performance.

Paterson, A.M., G.P. Pearce, and P.E. Hughes (1987). **Puberty in gilts handled pleasantly or unpleasantly.** In: *Manipulating Pig Production I. Proceedings of the Inaugural Conference of the Australasian Pig Science Association (APSA)* J.L. Barnett, E.S. Batterham, G.M. Cronin, C. Hansen, P.H. Hemsworth, D.P Hennessy, P.E Hughes, N.E. Johnston, and R.H. King, eds., Australasian Pig Science Association: Werribee, Australia, pp. 75-76.
NAL call number: SF391.3 A87
Descriptors: swine, sows, environment, hydrocortisone, housing, stress, welfare, behavior, sexual maturity.

Pearce, G.P. and A.M. Paterson (1993). **The effect of space restriction and provision of toys during rearing on the behaviour, productivity and physiology of male pigs.** *Applied Animal Behaviour Science* 36(1):11-28
NAL call number: QL750.A6
Descriptors: swine, stress, welfare, abnormal behavior, blood chemistry, hydrocortisone, boars, growth rate, pig housing, space requirements.

Pearce, G.P., A.M. Paterson, and A.N. Pearce (May 1989). **The influence of pleasant and unpleasant handling and the provision of toys on the growth and behaviour of male pigs.** *Applied Animal Behaviour Science* 23(1/2):27-37.
NAL call number: QL750.A6
Descriptors: animal behavior, pig housing, boars, handling, stress factors, growth.

Pearce, G.P., A.M. Paterson, and A.N. Pearce (1987). **The behavior and growth of male pigs handled pleasantly or unpleasantly during rearing.** In: *Manipulating Pig Production I. Proceedings of the Inaugural Conference of the Australasian Pig Science Association (APSA)* J.L. Barnett, E.S. Batterham, G.M. Cronin, C. Hansen, P.H. Hemsworth, D.P Hennessy, P.E Hughes, N.E. Johnston, and R.H. King, eds., Australasian Pig Science Association: Werribee, Australia, pp. 78-79.
NAL call number: SF391.3 A87
Descriptors: swine, boars, environment, hydrocortisone, stress, welfare, behavior.

Pedersen B., S.E. Curtis, K.W. Kelley, and H.W. Gonyou (1993). **Well-being in growing finishing pigs: environmental enrichment and pen space allowance.** In: *Livestock Environment IV: Fourth International Symposium, University of Warwick, Coventry, England, July 6-9, 1993* E. Collins and C. Boon, eds., American Society of Agricultural Engineers: St. Joseph, MI, pp.143-150.
NAL call number: SF91 L58
Descriptors: comparative study, swine, behavior, intensive housing, animal health, environmental factors.

Pedersen B., S.E. Curtis, K.W. Kelley, and H.W. Gonyou (1992). **Effect of enrichment and pen size on behavior productivity and immune response of growing-finishing pigs.** *Journal of Animal Science* 70(Supplement 1):49.
NAL call number: 49 J82
Descriptors: conference paper, space requirements, hiding area, manipulanda, floor levels, weight gain, growth.

Phillips, P.A., D. Fraser, and B.K. Thompson (1991). **Preference by sows for a partially enclosed farrowing crate.** *Applied Animal Behaviour Science* 32:35-43.
NAL call number: QL750.A6
Descriptors: animal behavior, housing, crates, stress factors.

Phillips, P.A., D. Fraser, and B.K. Thompson (December 1992). **Sow preference for farrowing crate width.** *Canadian Journal of Animal Science* 72(4):745-750.
NAL call number: 41.8 C163
Descriptors: farrowing crate, preference testing, floor space.

Phillips, P.A., B.K. Thompson, and D. Fraser (March 1988). **Preference tests of ramp designs for young pigs.** *Canadian Journal of Animal Science* 68(1):41-48.
NAL call number: 41.8 C163
Descriptors: loaders, preference testing, ramps, behavior.

Rushen, J. (1990). **Social recognition, social dominance and the motivation of fighting by pigs.** *Current Topics in Veterinary Medicine and Animal Science* 53:135-143.
NAL call number: SF600.C82
Descriptors: social interactions, aggressive behavior.

Schaefer, A.L., M.O. Salomons, A.K.W. Tong, A.P. Sather, and P. Lepage (August 1990). **The effect of environment enrichment on aggression in newly weaned pigs.** *Applied Animal Behaviour Science* 27(1/2):41-52.
NAL call number: QL750.A6
Descriptors: toys, aggressive behavior, postweaning interval.

Scheepens, C.J.M., M.J.M. Tielen, and P.R. Wiepkema (1990). **New possibilities of improving health and welfare of pigs by introduction of the specific stress-free (SSF) system.** *Tijdschrift voor Diergeneeskunde* 116(8):837-846.
Descriptors: pigs, stress, production, alternative housing.

Seabrook, M.F. (1984). **The psychological interaction between the stockman and his animals and its influence on performance of pigs and dairy cows.** *Veterinary Record* 115:84-87.
NAL call number: 41.8 V641
Descriptors: human-animal bond, fear, handling, behavior.

Semple, H.A., R. Berzins, R.T. Coutts, D.C. Secord, and Y.K. Tam (1986). **Commercial pig pen modifications for housing miniature swine during chronic studies.** In: *Swine in Biomedical Research* M.E. Tumbleson, ed., Vol. 1. Plenum Press: New York, pp. 153-157.
NAL call number: RB125.C68 1985.
Descriptors: chronic implants, blood sampling, pharmacokinetics studies, confinement unit, design, modifications.

Simmins, P.H., S.A. Edwards, and H.H. Spechter (1994). **Growth and body condition of sows given different feeding regimes during the rearing stage and through eight parities when housed in groups with straw bedding.** *Animal Production* 58(2):271-283.
NAL call number: 49 AN55
Descriptors: restricted feeding, housing, bedding, socialization, welfare, plane of nutrition, pregnancy, growth, longevity.

Smidt, D. (1990). **Animal welfare in cattle housing and pig housing and management.** *Landbauforschung Volkenrode* 40(2):138-156.
NAL call number: 18 L2353
Descriptors: alternative housing, species-specific feeding, economics, animal welfare.

Smith, C.P. (1994). ***Animal Models in Biomedical Research: Swine.*** *Special Reference Brief,* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 118p.
NAL call number: aS21 D27S64 no. 94-01
Descriptors: disease, physiology, behavior, stress, biomedical use.

Spitzfaden, D.M. and J.P. Hitchcock (1994). **Environment enrichment and its effects on performance of nursery age grower pigs.** *Journal of Dairy Science* 77(Supplement 1):209.
NAL call number: 44.8 J822
Descriptors: pigs, weanling, performance, abstract.

Stephens, D.B. and G.C. Perry (November 1990). **The effects of restraint, handling, simulated and real transport in the pig (with reference to man and other species).** *Applied Animal Behaviour Science* 28(1/2):41-55.
NAL call number: QL750.A6
Descriptors: restraint, handling, transport, vibration, noise, fear, welfare, cardiovascular response, feed intake.

Stolba, A. and D.G.M. Wood-Gush (1984). **The identification of behavioural key features and their incorporation into a housing system for pigs.** *Annales de Recherches Veterinaires* 15:287-289.
Descriptors: social behavior, exploration, alternative housing.

Stookey, J.M. and S. Lerche (1993). **Determining regrouping strategies in pigs using social preference testing.** *Journal of Animal Science* 71(Supplement 1):111(abstract).
NAL call number: 49 J82
Descriptors: conference paper, abstract, socialization, isolation, aggression, behavior.

Swanson, J.C. (1990). ***Welfare, Care and Husbandry of Swine: January 1979-August 1990.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 20p.
NAL call number: aZ5071.N3 no.91-14
Descriptors: bibliography, behavior, handling, transport, slaughter, housing.

Swanson, J.C. (1990). ***Swine Housing and Facilities: January 1985-August 1990***. *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 30p.
NAL call number: aZ5071.N3 no.91-15
Descriptors: bibliography, flooring, crate design, ventilation, temperature control.

Tan, S.S.L. and D.M. Shackleton (March 1990). **Effects of mixing unfamiliar individuals and of azaperone on the social behaviour of finishing pigs.** *Applied Animal Behaviour Science* 26(1/2):157-168.
NAL call number: QL750.A6
Descriptors: social behavior, social structure, mixing groups, agonistic behavior.

Terlouw, E.M.C., A.B. Lawrence, and A.W. Illius (1992). **Relationship between amphetamine and environmentally induced stereotypies in pigs**. *Pharmacology, Biochemistry, and Behavior* 43(2):347-355.
NAL call number: QP901 P4
Descriptors: stereotypies, catecholaminergic systems, locomotion, amphetamines, stress.

Tonn, S.R., D.L. Davis, and J.V. Craig (August 1985). **Mating behavior, boar-to-boar behavior during rearing, and soundness of boars penned individually or in groups from 6 to 27 weeks of age**. *Journal of Animal Science* 61(2):287-296.
NAL call number: 49 J82
Descriptors: mating behavior, growth rate, feed consumption, soundness, group housing, isolation.

Trudeau, V.L. and L.M. Sanford (1986). **Influence of season and social environment on the reproductive-endocrine status of the adult boar**. *Journal of Endocrinology* 108(Supplement):36.
NAL call number: 448.8 J8293
Descriptors: social isolation, group housing, testosterone, gonadotropin, seasonal cycles.

Van Putten, G. (1989). **The pig: A model for discussing animal behaviour and welfare**. *Applied Animal Behaviour Science* 22(2):115-128.
NAL call number: QL750.A6
Descriptors: sows, group housing, computerized feeding system, transponders.

Walton, J.R. (February 1991). **Ban on sow stalls and tethers**. [Letter] *Veterinary Record* 128(6):140.
NAL call number: SF601 I4
Descriptors: stalls, tether, housing, welfare.

Widowski, T.M. and S.E. Curtis (1990). **The influence of straw, cloth tassel, or both on the prepartum behavior of sows.** *Applied Animal Behaviour Science* 27:53-71.
NAL call number: QL750.A6
Descriptors: straw, cloth, prepartum behavior.

Wood-Gush, D.G.M. and K. Vestergaard (October 1991). **The seeking of novelty and its relation to play.** *Animal Behaviour* 43(4):599-606.
NAL call number: 410 B77
Descriptors: play, exploration, curiosity, welfare.

Young, R.J., J. Carruthers, and A.B. Lawrence (March 1994). **The effect of a foraging device (The "Edinburgh Foodball") on the behaviour of pigs.** *Applied Animal Behaviour Science* 39(3/4):237-247.
NAL call number: QL750.A6
Descriptors: pigs, gilts, foraging device, Edinburgh Foodball, diets, welfare, feed dispensers, enrichment.

Young, R.J., H.A. MacLeod, and A.B. Lawrence (1994). **Effect of manipulandum design on operant responding in pigs.** *Animal Behaviour* 47(6):1488-1490.
NAL call number: 410 B77
Descriptors: learning, operant conditioning, manipulanda.

Zanella, A.J., D.M. Broom, and J.C. Hunter (1992). **Sow housing behaviour and productivity are related to opioid receptor densities.** *Animal Production* 54(3):462-463.
NAL call number: 49 AN55
Descriptors: group housing, production, neurobiology.

Zhou, J.Z. and W.R. Stricklin (1992). **The influence of pen shape and size on crowding when density is constant.** *Journal of Animal Science* 70(Supplement 1):174.
NAL call number: 49 J82
Descriptors: livestock, space requirements, social stress, group size.

Ferrets

THE EFFECTS OF ENVIRONMENTAL ENRICHMENT IN FERRETS

Dorothy Einon
Department of Psychology, University College, London, Gower Street, London WC1E 6BT, England

Environmental enrichment and impoverishment are relative terms. We can measure them with reference to the normal keeping environment of laboratory animals or to the environment of their wild counterparts; in doing so we might form quite different conclusions. The environment of the average laboratory animal is clearly less complex than that of its wild counterpart, yet for many burrow-living species the average amount of visual and auditory stimulation may be higher in the laboratory (Milligan *et al.* 1993), and this is especially true during rearing. On the other hand the ready provision of food in all seasons, and the protection from both conspecific aggression and predation may make a good laboratory environment less stressful than a natural one if assessed on a life-time basis.

The ferret is a close relative of the polecat (*Mustela putorius*) and has been domesticated for 2000 years. It is widely kept as a working animal for use in trapping rabbits and is an increasingly popular laboratory animal: small enough to keep easily in the laboratory and relatively easy to breed and handle.

Social environment and impoverishment must always be measured with reference to the development stage of an animal and the environment in which this usually occurs. Feral ferrets are essentially solitary and nocturnal, but in captivity show much diurnal activity and individuals may be kept together, although males are often intolerant when in breeding condition. Keeping breeding males apart may reduce stress, but depriving ferret kits of conspecifics during the first month of life when much time is spent in play clearly impoverishes. By analogy with the rat (Potegal and Einon 1989, Morgan 1976, Einon and Sahakian 1983, Einon 1980) such impoverishment could alter later social interaction, sexual behavior, learning, drug tolerance, activity and body size. However as yet there has been little investigation of any of these questions in ferrets.

Most work on lifetime environmental enrichment and impoverishment has been carried out with rats and mice, work on ferrets has largely concerned the provision of objects and conspecifics for play during development. Exceptions include work by Korhonen and colleagues (Korhonen and Harri 1990, Korhonen *et al.* 1992) who

examined the effects of differing housing regimes on body weight and pelt quality, concluding that males housed singly had poorer pelt quality than males raised in groups, but that large, all male groups weighed less. Floor space used in housing also influenced pelt quality. They suggest that cages containing one male and one female produces the best pelt size and quality. If body weight and pelt quality reflect the health of animals then this is the optimal housing outside the breeding season. They found that social status correlated with weight; but whether this is causal is unclear. The authors also found that balls and bite cups reduced skin biting. The addition of "toys" to ferret cages is certainly desirable. Other work suggests that changing these toys on a day-to-day basis has advantages.

Where ferrets are kept in cages which restrict movements there are skeletal changes especially of the hind limbs (Slesarenko 1986), and in a related species social impoverishment has been found to induce more stereotyped behavior (Bildsøe *et al.* 1990). In hot climates there are reports that restriction, crowding and captivity may itself be stressful (Gazizov 1987). Heat stress, and such severe restriction of movement reflect poor husbandry, but while such work is of less relevance in countries with controls upon animal housing, giving ferrets and other mustelids access to space for exercise is clearly important. We should bear in mind that while the whole surface of a cage can provide a "gym" for young mice and rats, ferrets do not swing and climb in the same way.

Chivers and Einon (1982) found that some of the isolation induced effects on behavior which had been shown in rats also occurred in ferrets. Specifically, deprivation of rough and tumble social play caused hyperactivity which persisted into adulthood. Rats deprived in this way also showed poor reversal of previously learned tasks (Morgan 1976), increased susceptibility to amphetamine (Einon and Sahakian 1983) and poor spatial memory (Einon 1980). The fact that a group of socially reared ferrets whose environment was enriched with a series of changing tube systems (Weiss-Buerger 1981) were superior in maze learning and reversal, suggests that they may respond in a similar fashion. Chivers and Einon also showed that the isolation induced deficits in object exploration found in rats were absent in ferrets raised in isolation. The way in which ferrets manipulate objects is influenced by rearing environment. Russell (1990) found that isolated ferrets raised in enriched conditions (with a daily change of play objects) would choose the arm of a maze leading to the more prey-like of two play objects; were superior in capturing both crickets and moving prey-models, and that more elaborate prey-catching responses were elicited from enriched than impoverished animals when placed with dummy objects and remote controlled fur-covered toy cars. Captive as compared to laboratory rearing (Miller *et al.* 1990) also affects predatory skills, particularly the location of prey.

In conclusion although little work has been carried out on impoverishment and enrichment in ferrets, investigations so far suggest impoverishment, whether physical restriction, social or in manipulation of objects has wide ranging effects; especially when imposed during rearing.

References

Bildsøe, M., K.E. Heller, and L.F. Jeppesen (1990). **Stereotypies in adult ranch mink.** *Scientifur*14(3):169-177.

Chivers, S.M. and D.F. Einon (1982). **Effects of early social experience on activity and object investigation in the ferret, *Mustelo furo*.** *Developmental Psychobiology* 15:75-80.

Einon, D.F. and B.J. Sahakian (1983). **Environmentally induced differences in the susceptibility of rats to CNS stimulants and CNS depressants: Evidence against a unitary theory.** *Psychopharmacology* 52:191-203.

Einon, D.F. (1980). **Spatial learning and response strategies: Age, sex, and rearing differences in performance.** *Quarterly Journal of Experimental Psychology* 32: 473-489.

Gazizov, V.Z. (1987). **The peculiarities of fur-bearing animals under hot climatic conditions.** *Veterinariia (Moscow) 5:*26-29.

Korhonen, H. and M. Harri (1990). **Social influences on productive performance in farm-raised polecats.** *Scientifur 14(2):*89-94.

Korhonen, H., H. Tukiainen and M. Harri (1992). **Faktorer som paaverkar maarddjurens tillvaext.** *Finsk Paelstidskrift* 26:202-204.

Miller, B., D. Biggins, C. Wemmer, R. Powell, L. Hanebury, D. Horn, and A. Vargos (1990). **Development of survival skills in captive raised siberian polecats, *Mustela eversmanni*. 1. Locating prey.** *Journal of Ethology* 8(2):89-94.

Milligan, S.R., G.D. Sales and K. Khirnykh (1993). **Sound levels in rooms housing laboratory animals: An uncontrolled daily variable.** *Physiology and Behaviour* 6:1067-1076.

Morgan, M.J. (1976). **Effects of post-weaning environment on learning in the rat.** *Animal Behaviour* 24:415-420.

Potegal, M. and D.F. Einon (1989). **Aggressive behaviours in adult rats deprived of play fighting experience as juveniles.** *Developmental Psychobiology* 22:159-172.

Russell, J. (1990) ***Predatory object play in the ferret.*** University of London, PhD Thesis, University of London.

Slesarenko, N.A. (1986). **Changes in the femoral bone in fur animals under conditions of hypodynamia.** *Archives d'Anatomie d'Histologie et d'Embryologie* 90(5):80-86.

Weiss-Buerger, M. (1981). **An investigation of the influence of exploration and playing on learning by polecats, *mustela-putorius-x-mustela-furo*.** *Zeitschrift für Tierpsychologie* 551:33-62.

FERRET BIBLIOGRAPHY

Andrews, P.L.R. and O. Illman (1987). **The ferret.** In: *The UFAW Handbook on the Care and Management of Laboratory Animals* (6th edition) T.B. Poole, ed., LongmanScientific and Technical: Harlow, Essex, England, pp. 436-455.
NAL call number: QL55.U5 1987
Descriptors: ferret, husbandry, health, biology.

Anonymous (1991). **Council of Europe passes recommendations on the husbandry of fur-bearing animals in the context of the European agreement on animal protection. [Europarat beschliesst Empfehlungen fuer das Halten von Pelztieren im Rahmen des Europaeischen Uebereinkommens zum Schutz von Tieren.]** *Deutsche Pelztierzuechter* 65(2):22-26.
Descriptors: ferrets, polecats, foxes, coypus, chinchillas, animal welfare, husbandry, stunning.

Apfelbach, R. and U. Wester (1977). **The quantitative effect of visual and tactile stimuli on the prey-catching behaviour of ferrets.** *Behavioural Processes* 2(2):187-200.
NAL call number: QL750 B4
Descriptors: ferret, prey-catching, dummies, visual stimuli, tactile stimuli.

Auerlich, R.J., S.J. Bursian, H.C. Napolitano, and R.J. Balander (1991). **Single-, double-, and triple-stocking in cages of different sizes: Stress effects in minks. [Einfach-, Zweifach-, und Dreifachbesetzung bei verschiedener Kaefiggroesse: Wirkung auf Stress beim Nerz.]** *Deutsche Pelztierzuechter* 65(5):97-100.
Descriptors: mink, housing, stress, stocking rate, husbandry.

Bacon, B. (1992). **The ferret as a laboratory animal: Housing and handling.** *Stal Sciences et Techniques de l' Animal de Laboratoire* 17(3):127-133.
Descriptors: ferret, behavior, housing, handling, physiology.

Biben, M. (1982). **Sex differences in the play of young ferrets.** *Biology of Behaviour* 7(4):303-308.
NAL call number: QL750 B52
Descriptors: ferret, male, female, play, sex differences, aggression.

Bildsøe, M., K.E. Heller, and L.L. Jeppesen (1990). **Stereotypies in adult ranch mink.** *Scientifur* 14(3):169-177.
NAL call number: SF402 S3
Descriptors: mink, male, female, stereotypic behavior.

Bildsøe, M., K.E. Heller, and L.L. Jeppesen (1990). **Stereotypies in female ranch mink: Seasonal and diurnal variations.** *Scientifur* 14(4):243-247.
NAL call number: SF402 S3
Descriptors: mink, abnormal behavior.

Bildsøe, M., K.E. Heller, and L.L. Jeppesen (1991). **Effects of immobility stress and food restriction on stereotypies in low and high stereotyping female ranch mink.** *Behavioural Processes* 25(2):179-189.
NAL call number: QL750 B4
Descriptors: mink, stress, starvation, feeding, behavior, restraint.

Buckingham, C.J. (1979). **The activity and exploratory behaviour of the weasel, *Mustela nivalis*.** *Doctoral Dissertation,* available from British Library, Lending Division, Ref. No. D30923/80, 254 pp.
Descriptors: weasels, activity, behavior, exploration.

Bunnell, T. (1981). **Playful behaviour in relation to family group activity in polecats (Mustelidae).** *Doctoral Dissertation, Open University* Available from British Library, Lending Division, Ref. No. D44361/83, 222pp.
Descriptors: mustelids, play behavior, social groups, group activity.

Burke, T.J. (1981). **Ferrets.** *Scientific proceedings of the annual meeting of the American Animal Hospital Association* 48th:77-79.
NAL call number: 41.9 AM36
Descriptors: ferret, reproduction, housing, restraint, nutrition, anesthesia.

Chivers, S.M. and D.F. Einon (1982). **Effects of early social experience on activity and object investigation in the ferret.** *Developmental Psychobiology* 15(1):75-80.
NAL call number: QP351 D4
Descriptors: ferret, male, female, isolation, hyperactive, play, toys, exploratory behavior.

Clapperton, B.K. (1989). **Scent-marking behavior of the ferret (*Mustela furo L*).** *Animal Behaviour* 38(3):436-446.
NAL call number: 410 B77
Descriptors: ferret, male, female, behavior, seasons, communication.

Collins, B.R. (1987). **The environmental requirements and diseases of rabbits, rodents, and ferrets.** In: *Anon. Proceedings of the First International Conference on Zoological and Avian Medicine.* Association of Avian Veterinarians and the American Association of Zoo Veterinarians, (place of publication not given), pp. 359-363.
Descriptors: ferret, rabbit, rodents, housing, husbandry, diet, diseases, captivity.

Diener, A. (1985). **Behavior analysis of polecat ferrets during social play [Verhaltensanalysen zum Sozialspiel von Iltisfrettchen (*Mustela putorius f. furo.*]** *Zeitschrift für Tierpsychologie* 67(114):179-197.
NAL call number: 410 Z35
Descriptors: ferret, male, female, play, social interaction, behavior.

Donovan, B.T. (1985). **Wheel-running during anoestrus and oestrous in the ferret.** *Physiology and Behavior* 34(5):825-829.
NAL call number: QP1 P4
Descriptors: ferret, female, wheel-running, gonadectomy, circadian rhythms.

Eastment, A.M. and R.N. Hughes (1968). **Reactions of ferret-polecat hybrids to complexity and change.** *Perceptual and Motor Skills* 26(3):935-938.
Descriptors: ferret-polecat hybrid, exploration, behavior.

Foster-Turley, P. and H. Markowitz (1982). **A captive behavioural enrichment study with Asian small-clawed river otters (*Aonyx cinerea*).** *Zoo Biology* 1(1):29-43.
NAL call number: QL77.5 Z6
Descriptors: otters, care, husbandry, environmental enrichment, activity, feeding, hunting.

Frederick, K.A. and J.G. Babish (1985). **Compendium of recent literature on the ferret [1977-1985.]** *Laboratory Animal Science* 35(3):298-318.
NAL call number: 410.9 P94
Descriptors: ferret, bibliography, behavior, reproduction.

Garcia Botey, C., J.C. Fontanillas and F. Calderon (1991). **A study on the reproductive biology and maternal behaviour of ferrets in captivity. [Estudio experimental sobre la biología de la reproducción y comportamiento maternal del turon en cautividad.]** *Avances en Alimentación y Mejorá Animal* 31(2):51-58.
NAL call number: SF95 A9
Descriptors: ferret, reproduction, weanling, housing, nutrition.

Gazizov, V.Z. (1987). **The peculiarities of fur-bearing animals kept under hot climatic conditions.** *Veterinariia* 5:26-29.
NAL call number: 41.8 V6426
Descriptors: mustelids, housing, environment, circulatory system.

Gupta, A.S. (1988). **The structure and development of play in ferrets and dogs.** *Index to Theses Accepted for Higher Degrees in the Universities of Great Britain and Ireland* 37(4):1608-1609.
NAL call number: 241.8 AS7
Descriptors: ferret, dog, play, behavior, social interactions.

Hansen, S.W. and A. Brandt (1989). **Effects of cage size and nest box on the haematological/enzymological status and physiological stress levels in mink kits.** *Scientifur* 13(3):185-192.
NAL call number: SF402 S3
Descriptors: mink, male, female, neonates, weanling, husbandry, nest boxes, caging, stress, cortisol.

Hansen, S.W. (1990). **Activity pattern of lactating mink and the effect of water trays or wire netting cylinder in mink cages.** *Scientifur* 14(3):187-193.
NAL call number: SF402 S3
Descriptors: mink, female, reproduction, behavior, activity.

Hillman, C.N. and J.W. Carpenter (1983). **Breeding biology and behavior of captive Black-footed ferrets, *Mustela nigripes*.** *International Zoo Yearbook* 23:186-191.
NAL call number: QL76 I5
Descriptors: ferret, black-footed, reproduction, behavior.

Hughes, R.N. (1967). **Effects of intertrial confinement and brightness change on ferret alternation behavior.** *Psychological Reports* 20(2):679-681.
Descriptors: ferret, behavior, activity, exploratory behavior, environment, light.

Jedrzejewska, B. (1989). **Variation in weasels' response to transient and resident bank voles, enclosure experiments.** *Acta Oecologica-Oecologica Generalis* 10(2):149-154.
NAL call number: QK901 A1033
Descriptors: weasel, bank vole, diet, predation, prey, food preferences.

Jeppesen, L.L. and H. Falkenberg (1990). **Effects of play balls on peltbiting, behaviour, and level of stress in ranch mink.** *Scientifur* 14(3):179-186.
NAL call number: SF402 S3
Descriptors: mink, stress, toys, behavior.

Kaufman, L. (1979). **Foraging strategies: Laboratory simulations.** *Dissertation Abstracts International* 40(1-B):489.
NAL call number: Film S-1806.
Descriptors: ferret, chicken, rat, feeding behavior.

Kemmerer, D. (1989). **What technicians need to know about ferrets.** *Journal of the American Veterinary Medical Association* 194(12):1809.
NAL call number: 41.8 Am3
Descriptors: ferret, handling, breeding, grooming, behavior.

Korhonen, H. and M. Harri (1985). **Seasonal changes in polecats.** *Finsk Palstidskrift* 19(9):484-486.
Descriptors: polecat, male, female, behavior, seasons.

Korhonen, H. and M. Harri (1990). **Social influences on productive performance in farm-raised polecats.** *Scientifur* 14(2):89-94.
NAL call number: SF402 S3
Descriptors: polecat, male, female, weanling, housing, isolation, social groups, body weight, behavior.

Korhonen, H. and M. Harri (1992). **Social influences on weight gain in farm-raised polecats. [Faktorer som paaverkar maarddjurens tillvaext.]** *Finsk Paelstidskrift* 26(8-9):202-204.
Descriptors: polecats, social behavior, body weight, social groups.

Korhonen, H., M. Harri, L. Nurminen, K. Rouvinen, and T. Laitila (1985). **Seasonal changes in behavioural patterns of farmed polecats (*Mustela putorius*).** *Scientifur* 9(4):264-271.
NAL call number: SF402 S3
Descriptors: polecat, behavior, feeding.

Korhonen, H., H. Tukiainen, and M. Harri (1990). **Effect of group and sex combination on productive performance of farmed polecats.** *Zeitschrift für Versuchstierkunde* 33(2):79-83.
NAL call number: 410 Z36
Descriptors: polecat, male, female, housing, social groups, body weight, pelt quality.

Kusak, J. and D. Huber (1991). **Curiosity in wild carnivores. [Istrazivanje radoznalosti mesozdera.]** *Veterinarski Arhiv* 61(6):395-409.
NAL call number: 41.8 V6416
Descriptors: polecat, behavior, zoo animals, wildlife.

Lazar, J.W. and G. Beckhorn (1971). **Mother-young relationships in the ferret.** *American Zoologist* 11(4):618.
NAL call number: 410 Am3
Descriptors: ferret, nursing, play behavior, body weight.

Lazar, J.W. and G.D. Beckhorn (1974). **Social play or the development of social behavior in ferrets, *Mustela putorius*.** *American Zoologist* 14(1):405-414.
NAL call number: 410 Am3
Descriptors: ferret, play, behavior, development.

Lester, D. and C. Dunn (1989). **A test of Sheldon's theory of personality in ferrets.** *Perceptual and Motor Skills* 69(3-I) 962.
Descriptors: ferret, male, female, behavior, personality, body weight.

Liang, J. and Y. Cheng (1985). **Daily activity rhythms of fitches and alpine weasels.** In: *Contemporary Mammology in China and Japan* T. Kawamichi, ed., Mammalogical Society of Japan: Japan, pp. 1-195.
Descriptors: fitch, alpine weasel, feeding, activity, behavior, predation.

Lode, T. (1989). **Prey storing in the polecat (*Mustela putorius*). [Le comportement de mise en reserve alimentaire des proies chez le putois (*Mustela putorius*).]** *Cahiers Ethologie Appliquee* 9(1):19-30.
Descriptors: polecat, seasons, diet, feeding behavior.

Lode, T. (1991). **Environment exploitation and space organization of two European mustelids: Stone marten (*Martes foina*) and polecat (*Mustela putorius*). [Exploitation des milieux et organisation de l'espace chez deus Mustelides europeens: La fouine et le putois.]** *Vie et Milieu* 41(1):29-38.
NAL call number: QH301 V5
Descriptors: polecat, Stone marten, space, feeding zones, shelter, hiding place, diet, foraging behavior, behavior.

Mankovich, N.J. (1982). **Sex differences in play-wrestling in the ferret (*Mustela putorius*).** *Dissertation Abstracts International (B)* 43(3):651.
NAL call number: Film S-1806
Descriptors: ferret, male, female, play behavior, reproduction, body weight.

Miller, B.J. and S.H. Anderson (1989). **Courtship patterns in induced estrous and natural estrous domestic ferrets, *Mustela putorius furo*.** *Journal of Ethology* 7(2):65-74.
NAL call number: QL750 J68
Descriptors: ferret, male, female, pre-copulation behavior, courtship.

Milligan, S.R., G.D. Sales, and K. Khirnykh (1993). **Sound levels in rooms housing laboratory animals: An uncontrolled daily variable.** *Physiology and Behavior* 53(6):1067-1076.
NAL call number: QP1 P4
Descriptors: ferret, cats, mouse, rabbit, rat, sound, behavior, low vs. high frequency.

Moeller, S. (1990). **The need for nest boxes and drop-in bottoms in the whelping period of female mink.** *Scientifur* 14(2):95-100.
NAL call number: SF402 S3
Descriptors: mink, housing, nest boxes, body weight, behavior, reproduction.

Moody, K.D., T.A. Bowman, and C.M. Lang (1985). **Laboratory management of the ferret for biomedical research.** *Laboratory Animal Science* 35(3):272-279.
NAL call number: 410.9 P94
Descriptors: ferret, husbandry, diet, handling, breeding.

Morgan, R. L. (1990). **Carnivores, basic needs, handling, and care.** *Symposium: Animal Welfare Compliance for Study Directors; presented at the Eleventh Annual Meeting of the American College of Toxicology, Orlando, FL, October, 1990* Production Plus, Inc., Closter, NJ, Videocassette, 31 minutes.
NAL call number: Videocassette no. 971
Descriptors: ferret, mink, dog, cat, social interaction, husbandry, environmental factors, guidelines, regulations, resource information.

Otis, R.E., C.D. Andrina, and N.J. Clemens (1971). **Exploratory behavior in mink (*Mustela vison*) and ferrets (*M. putorius*).** *American Zoologist* 11(4):631.
NAL call number: 410 Am3
Descriptors: ferret, mink, male, female, exploration, behavior.

Owen, C. (1971). **Domestication of the ferret.** In: *Domestikationforschung und Geschichte der Haustiere: Internationales Symposion. (History of Domestic Animals: International Symposium in Budapest, Hungary on April 19-23, 1971),* J. Matolcsi, ed., Akademiai Kiado: Budapest, Hungary, pp.115-117.
NAL call number: S494 M3
Descriptors: ferret, mustelids, hybrid behavior, activity, hunting, conference paper.

Paradis, M. (1987). **A guide to the pet ferret.** *Medecin Veterinaire du Quebec* 17(2):63-69.
NAL call number: SF602 M8
Descriptors: ferret, pet, husbandry, behavior, diet, diseases.

Pellis, S.M. (1983). **The frequency and pattern of play behaviour.** *Mammalia* 47(2):272-274.
NAL call number: 410 M31
Descriptors: mustelids, play, social groups, behavior.

Pollard, J.S. and R.F. Lewis (1969). **Ferrets do learn mazes.** *Journal of Biological Psychology* 11(1):40-43.
Descriptors: ferret, learning, maze.

Poole, T.B. (1978). **An analysis of social play in polecats (Mustelidae) with comments on the form and evolutionary history of the open-mouth play face.** *Animal Behaviour* 26(1):36-49.
NAL call number: 410 B77
Descriptors: polecat, mink, play, behavior, biting.

Poole, T.B. (1973). **The aggressive behavior of individual male polecats (*Mustela putorius, M. furo*) and hybrids towards familiar and unfamiliar opponents.** *Journal of Zoology Proceedings of the Zoological Society of London* 170(3):395-414.
NAL call number: 410.9 L84P
Descriptors: ferret, polecat, ferret-polecat hybrid, aggression, social groups.

Pozdnyakova, L.Eh. and N.K. Shul'gina (1985). **The effect of floor space and group size on fitch growth and pelt quality. [Vliyanie ploschadi vygula i velichiny gruppy na rost i kachestvo shkurki khor'kov.]** *Sbornik nauchnykh trudov-NII pushnogo zverovodstva i krolikovodstva* 32:112-119.
Descriptors: polecat, housing, space cages, growth, pelt quality, husbandry, social groups.

Sjogard, B. (1978). **Ferret (*Mustela putorius*) rearing (Finland). (Illeruppfodning)** *Vara palsdjur* 49(12):314-316, December 15, 1978.
NAL call number: 410 V42
Descriptors: ferret, housing, handling, husbandry.

Slesarenko, N.A. (1986). **Changes of the femoral bone in fur-bearing animals under conditions of hypodynamia.** *Arkhiv anatomii, gistolgii, i embriologii* 90(5):80-86.
NAL call number: QL801 A7
Descriptors: mustelids, restricted movement, skeletal changes.

Soenderup, M. (1990). **Balls and bite cups can reduce skin biting. [Bidekopper og bolde kan reducere pelsgnav.]** *Dansk Pelsdyravl* 53(9):396-398.
NAL call number: 412.628 D23
Descriptors: mink, abnormal behavior, skin biting, toys.

Sokolov, V.E. and V.V. Rozhnov (1988). **Marking activity in polecat: Effect of physiological and social factors.** *Izvestiia Akademii nauk SSSR, Seriia biologicheskaia* 6:805-813. (Translated to English in Biological Bulletin of the Academy of Sciences of the USSR)
NAL call number: 511 SA2B
Descriptors: polecat, reproduction, scent marking, social organization.

Stockman, E.R., R.S. Callaghan, C.A. Gallagher, and M.J. Baum (1986). **Sexual differentiation of play behavior in the ferret.** *Behavioral Neuroscience* 100(4):563-568.
NAL call number: QP351 B45
Descriptors: ferret, male, female, prepubertal play, toys, endocrine control, age factors.

Stockman, E.R., H.E. Albers, and M.J. Baum (1985). **Activity in the ferret: Oestradiol effects and circadian rhythms.** *Animal Behaviour* 33(1):150-154.
NAL call number: 410 B77
Descriptors: ferret, activity, endocrine system, behavior, circadian rhythms.

Weiss-Buerger, M. (1981). **An investigation on the influence of exploration and playing on learning by polecats (*Mustela putorius X Mustela furo*).** *Zeitschrift für Tierpsychologie* 55(1):33-62.
NAL call number: 410 Z35
Descriptors: ferret-polecat hybrid, behavior, play, tubes, learning, maze.

Whiteside, A.J., R. Kilgour, and A.J. Pearson (1986). **Courtship and mating behaviour of the domestic fitch (*Mustela putorius furo*).** *Scientifur* 10(1):44-48.
NAL call number: SF402 S3
Descriptors: ferret, male, female, breeding, behavior.

Willis, L.S. and M.V. Barrow (1971). **The ferret (*Mustela putorius furo L.*) as a laboratory animal.** *Laboratory Animal Care* 21(5):712-716.
NAL call number: 410.9 P94
Descriptors: ferret, diet, behavior, breeding.

Rabbits

RABBITS

Debbie Gunn and David B. Morton
Department of Biomedical Science and Ethics, The Medical School, University of Birmingham, Edgbaston, Birmingham B15 2TT, England

This short paper introduces the general housing and husbandry of laboratory rabbits. The behavior of wild rabbits is compared with that of their laboratory counterparts, and consideration is given to their behavioral needs from the welfare point of view as well as to the effects of husbandry on scientific research.

The natural environment

The wild rabbit is gregarious, living in family groups in natural colonies or warrens (Cowan 1987). Rabbits spend most of their time underground in burrows during the diurnal period and venture above ground at night when they are generally more active, feeding mainly at dawn and dusk (Mykytowycz 1958). Females dig burrows to prepare nests for the protection of their young which are born helpless and blind; they also serve as a haven in an emergency (Cowan and Bell 1986). In terms of their social activities, stable breeding groups are formed with linear hierarchies of both males and females (Mykytowycz 1958, Cowan 1987). Once stabilized, the order of dominance is generally sustained and fighting is rare (Mykytowycz and Rowley 1958, Lockley 1961); the social organization being controlled by scent marking and territorial patrols which involve chin-marking from cutaneous glands, urination, defecation, and behavioral displays. Male rabbits naturally distance themselves to avoid conflict (Mykytowycz 1958) while females will only fight to compete for burrows if they are in limited supply (Kunkele 1992). Social behaviors include allogrooming and group foraging activities. Rabbits adopt "look-out" positions for potential predators and foot-thumping serves as an alarm signal to alert the colony (McFarland 1987), from which the rabbits run at high speeds for cover, often leaping and jumping obstacles in the process.

Observations on domestic rabbits have shown that there are few differences in their behavior compared with their wild counterparts (Mykytowycz and Hesterman 1975, Bell 1984) so it remains likely that the potential for the full range of behavior of wild rabbits is still present genetically, despite some selection for physical, physiological and behavioral traits.

The laboratory environment

Whilst the quality and quantity of laboratory bred rabbits have improved over the past 40 years or so, their psychological well-being has largely been neglected. Advances have included genetic selection for clearly defined pure-bred strains, such as New Zealand Whites, Dutch and Lops, with traits for docility, reproductive performance and growth as well as a vastly improved health status. Other improvements include a standardized complete diet, and a protected and standardized environment of caging, ventilation, lighting, temperature and humidity (Clough 1982). However, such standardized cage designs have evolved mainly for the ease of husbandry and economic considerations, and it is apparent that some of these designs have had undesirable effects on the animals, particularly a reduction in space (Gunn and Morton 1994). Physical and social isolation offers no mental stimulation (Huls *et al.* 1991). Furthermore, the constant feeding of a highly refined pelleted diet is likely to be monotonous (BVAAWF/FRAME/RSPCA/UFAW 1993). There is evidence that all of these have lead to both physiological (Lehmann 1984, Wieser 1984) and psychological problems. Caged rabbits also show behavioral abnormalities including stereotypies (Stauffacher 1992, BVAAWF/FRAME/RSPCA/UFAW 1993) which may be signs of discomfort, mental suffering and distress (Lawrence and Rushen 1993, Gunn 1994) even though the animals are able to grow and reproduce. There is an ethical mandate to improve the animal's well-being (Broom 1988, Wemelsfelder 1984). It is important to minimize suffering not only for welfare reasons, but also because such "suffering" may result in a range of physiological or psychological changes which could add unintentional variables to the experimental design and affect the accuracy and reliability of the scientific results (BVAAWF/FRAME/RSPCA/UFAW 1993, Gunn 1994). This in turn may lead to more animals being used in research than is necessary.

Conventional housing for rabbits

For many years rabbits have been housed in purpose-built metal cages. Single caging isolates rabbits from physical and visual contact and prevents any social interaction, particularly in solid-walled cages (Gunn 1994, Huls *et al.* 1991). They also restrict movement (with minimal floor area (Gunn and Morton 1994, BVAAWF/FRAME/RSPCA/UFAW 1993) and height) so that rabbits are unable to perform normal ambulation or rearing activities (Gunn and Morton 1994, BVAAWF/FRAME/RSPCA/UFAW 1993). The barren environment provides no stimulation which leads to abnormal behavior patterns such as bar-biting and clawing of the cage (Stauffacher 1992, Gunn and Morton 1994). These stereotypic activities substitute for natural behaviors which are denied by standard laboratory conditions (Stauffacher 1992) and may indicate frustration, anxiety or boredom, and develop in stages involving a progressive narrowing of the behavioral repertoire (Gunn 1994). A

lack of exteroceptive stimulation, restricted movement and social inhibition are reported to be initial causal factors (Dantzer 1986). Other indicators of boredom have been observed such as hunched posture (Gunn and Morton 1994), inertia (Metz 1984), and a staring coat and dull eyes which may also indicate poor health (Wallace *et al.* 1990). As the caged environment is not sufficient to permit an adequate level of physical activity, caged rabbits can develop osteoporosis (Lehmann 1984) and back-bone distortions (Wieser 1984), and a high percentage of intestinal disorders (Jackson 1991) may be a result of "caging stress".

Welfare and behavioral needs

It is no longer considered acceptable to only provide for animals' physiological needs or to provide conditions which maximize productivity (Dawkins 1980). The care of captive animals should also include consideration of their behavioral needs. Some behaviors which are essential to the animal's well-being are not provided for in the laboratory, such as allogrooming, digging for the purpose of nest-building (Podberscek *et al.* 1991), and foraging (Stauffacher 1992). The inability to perform certain behaviors is thought to lead to intention movements, or inappropriate or abnormal behaviors (Dantzer 1986, Lawrence and Rushen 1993). Subjective states, such as boredom and frustration, can be evaluated through the use of careful experimental design. Other abnormal activities include under- or over- grooming and eating, leading to a staring coat, hair-balls (intestinal stasis - Jackson 1991), weight loss and obesity, respectively. These conditions are commonly observed in singly caged rabbits (BVAAWF/FRAME/RSPCA/UFAW 1993, Gunn 1994). Such behaviors are maladaptive and provide clear evidence of a need for some environmental improvement. These activities are often associated with apathy and a refusal to respond which are indicative of psychological disorders and show a lack of adaptation rather than a coping strategy (Lawrence and Rushen 1993).

Improvements in rabbit housing

The natural social organization of this species should influence how we house rabbits in laboratories. Since wild rabbits live in groups containing at least one other rabbit of the same sex (Cowan 1987), it seems sensible to suggest that they should at least be housed in pairs, with the exception of mature males (unless they have been castrated - Gunn 1994). Whether grouping rabbits in pairs in cages, in floor pens, or in breeding groups, they should have opportunities for "exercise" and social interaction (BVAAWF/FRAME/RSPCA/UFAW 1993, Batchelor 1991), allowing them more control over their immediate environment. As they are social animals they mix well at an early age, although there may be problems with removal or replacement of adults in an established group (Hammond and Love 1989, Love and Hammond 1991). Males can

also be group-housed until they reach sexual maturity, but may then have to be castrated to be housed successfully in stable groups for lengthy periods. If rabbits must be caged individually for experimental reasons, enriching the cage environment has been shown to be beneficial. The cages should be, as a minimum, large enough to enable the rabbits to sit upright and lie out at full stretch (Gunn 1994), have visual contact with other rabbits, an area to withdraw to, a shelf for resting on (Stauffacher 1992) as well as an improved visual field. The provision of roughage such as hay (Gunn 1994), and straw, a varied diet and objects to gnaw on (Stauffacher 1992) or manipulate (e.g., wooden shapes - Huls *et al.* 1991) have been suggested to alleviate boredom and stereotypic activities (Brooks *et al.* 1993, Gunn 1994) and thus substantially improve welfare. Some of these enrichments apply equally to rabbits grouped in pens. It is recommended from an animal welfare point of view that whenever possible rabbits should be group-housed (Home Office 1989, Batchelor 1991) unless the experimental design prohibits it.

References

Batchelor, G.R. (1991). **Group housing on floor pens and environmental enrichment in Sandy Lop rabbits.** *Animal Technology: Journal of the Institute of Animal Technology* 42 (2):109-120.

Bell, D.J. (1984). **The behaviour of rabbits: Implications for their laboratory management.** In: *Standards in Laboratory Animal Management (2)* Proceedings of UFAW Symposium, Potters Bar.

Brooks, D.L., W. Huls, C. Leamon, J. Thomson, J. Parker and S. Twomey (1993). **Cage enrichment for female New Zealand White rabbits.** *Laboratory Animals* 22:30-35.

Broom, D.M. (1988). **The scientific assessment of animal welfare.** *Applied Animal Behaviour Science* 20:5-19.

BVAAWF/FRAME/RSPCA/UFAW (1993). **Refinements in rabbit husbandry. 2nd Report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement.** *Laboratory Animals* 27:301-329.

Clough, G. (1982). **Environmental effects on animals used in biomedical research.** *Biological Review* 57: 487-523.

Cowan, D.P. (1987). **Group living in the European rabbit: mutual benefit or resource localization?** *Journal of Animal Ecology* 56:779-795.

Cowan, D.P. and D.J. Bell (1986). **Leporid social behaviour and social organisation.** *Mammal Review* 16:169-179.

Dantzer, R. (1986). **Behavioural, physiological and functional aspects of sterotyped behaviour: A review and re-interpretation.** *Journal of Animal Science* 62:1776-1786.

Dawkins, M. (1980). ***Animal Suffering: The science of animal welfare.*** Chapman and Hall Ltd: London.

Gunn, D. (1994). ***Evaluation on welfare in the husbandry of laboratory rabbits.*** PhD Thesis, University of Birmingham.

Gunn, D. and D.B. Morton (1994). **The behaviour of single-caged and group-housed laboratory rabbits. In: *Welfare and Science.*** *Proceedings of the 5th FELASA Symposium,* J. Bunyan, ed., Royal Society of Medicine Press: London, p80-84.

Hammond, K. and J.A. Love (1989). ***The use of fentanyl and droperidol for group formation in adult rabbits.*** CALAS Conference, Ottowa, Ontario.

Home Office (1989). ***Code of Practice for the Housing and Care of Animals Used in Scientific Procedures.*** Her Majesty's Stationery Office: London.

Huls,W.L., D.L. Brooks and D. Bean-Knudsen (1991). **Response of adult New Zealand White rabbits to enrichment objects and paired housing.** *Laboratory Animal Science* 41:609-612.

Jackson, G. (1991). **Intestinal stasis and rupture in rabbits.** *The Veterinary Record* 129:287-289.

Kunkele, J. (1992). **Infanticide in wild rabbits.** *Journal of Mammology* 73:317-320.

Lawrence, A.B. and J. Rushen (1993). ***Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare.*** CAB International, Wallingford, Oxon.

Lehmann, M. (1984). ***Beurteilung der Tiergerechtheit handelsueblicher Batteriekaefige fuer Mastkaninchen.*** Report Swiss Federal Veterinary Office: Bern (cited in Stauffacher, M. 1992).

Lockley, R.M. (1961). **Social structure and stress in the rabbit warren.** *Journal of Animal Ecology* 30:385-423.

Love, J.A. and K. Hammond (1991). **Group housing rabbits.** *Laboratory Animals* 20:37-43.

McFarland, D. (1987). ***The Oxford Companion to Animal Behaviour.*** Oxford University Press.

Metz, J.H.M. (1984). **Effects of early handling in the domestic rabbit (Abstract).** *Applied Animal Ethology* 11:86-87.

Mykytowycz, R. (1958). **Social behaviour of an experimental colony of wild rabbits (*Oryctolagus cuniculus L.*) 1. Establishment of the colony.** *CSIRO Wildlife Research* 3:7-25.

Mykytowycz, R. and E.R. Hesterman (1975). **An experimental study of aggression in captive European rabbits.** *Behaviour* 52:104-117.

Mykytowycz, R. and I. Rowley (1958). **Continuous observations of the activity of the wild rabbit during 24 hour periods.** *CSIRO Wildlife Research* 3:26-31.

Podberscek, A.L., J.K. Blackshaw and A.W. Beattie (1991). **The behaviour of group penned and individual caged laboratory rabbits.** *Applied Animal Behaviour Science* 28:353-356.

Stauffacher, M. (1992). **Group housing and enrichment cages for breeding, fattening and laboratory rabbits.** *Animal Welfare* 1:105-125.

Wemelsfelder, F. (1984). **Animal boredom: Is a scientific study of the subjective experiences of animals possible?** In: *Advances in Animal Welfare Science.*, M.W. Fox and L.D. Mickley, eds., Martinus Nijhoff Publishers: Boston, pp. 115-153.

Wieser, R.V. (1984). **Zur Tiergerechtheit handelsublicher Batteriekariger für Hauskaninchen Zibben.** Report Swiss Federal Veterinary Office: Bern (cited in Stauffacher, M. 1992).

Wallace, S., J. Sanford, M.W. Smith and K.V. Spencer (1990). **The assessment and control of the severity of scientific procedures on laboratory animals. Report of the LASA Working Party (Assessment and control of severity).** *Laboratory Animals* 24:97-130.

RABBIT BIBLIOGRAPHY

Adams, C.E. (1987). **The rabbit.** In: *The UFAW Handbook on the Care and Management of Laboratory Animals (6th ed.)* T. Poole, ed., Longman Scientific and Technical: Harlow, Essex, pp. 416-435.
NAL call number: QL55.U5 1987
Descriptors: housing, breeding, normal behavior, handling.

Allen, T. (1994). ***Housing, Husbandry, and Welfare of Rabbits, January 1979-January 1994***. *Quick Bibliography 94-16* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 45.
NAL call number: aZ5071.N3
Descriptors: housing, husbandry, welfare, management, behavior.

Anderson, C.O. (1970). **Experimental factors which influence the development of sexual, maternal and social behaviors in the rabbit.** *Dissertation Abstracts International. B: The Sciences and Engineering* 30(11):5247-5248.
NAL call number: Z5055 U49D53
Descriptors: estradiol, testosterone, progesterone, group composition, sexual, maternal, social.

Anderson, C.O., V.H. Denenberg, and M.X. Zarrow (1972). **Effects of handling and social isolation upon the rabbit's behaviour.** *Behaviour* 43(1):165-175.
NAL call number: 410 B393
Descriptors: gestation, sexual activity, group vs. solitary housing, handling, social isolation.

Anon. (1988). **Code of recommendations for the welfare of rabbits.** *Journal of Applied Rabbit Research* 11(1):8-10.
NAL call number: QL737 L3206
Descriptors: water, cage design, slaughter, housing, welfare, code.

Anon. (1982). **Draft code of recommendations for the welfare of rabbits, draft of December 1982.** *Farm Animal Welfare Council of the United Kingdom,* Tolworth, Surbiton KT6 7NF, UK; Block B, Government Buildings, Hook Rise South. 14pp.
Descriptors: housing, husbandry, production, behavior, welfare.

Batchelor, G.R. (August 1991). **Group housing on floor pens and environmental enrichment in sandy lop rabbits.** *Animal Technology: Journal of the Institute of Animal Technicians* 42(2):109-120.
NAL call number: QL55.I5
Descriptors: social groups, solitary housing, hierarchy, space, behavioral repertoire, environmental enrichment, group housing.

Beaver, B.V. (1989). **Environmental enrichment for laboratory animals.** *ILAR News* 31(2):5-11.
NAL call number: QL55.A1I43
Descriptors: artificial appliances, social peers, foraging, environmental control.

Black-Cleworth, P. and G. Verberne (1975). **Scent-marking, dominance and flehmen behavior in domestic rabbits in an artificial laboratory territory.** *Chemical Senses and Flavor* 1(4):465-494.
NAL call number: QP456 C5
Descriptors: pheromone, urine, social behavior, chemical cues, secretion, odors, scent-marking, dominance, flehmen behavior.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Brenner, F.J. and D.P. Flemming (1979). **Behavioral determination of dominance in captive male cottontail rabbits (*Sylvilagus floridanus*).** *Proceedings of the Pennsylvania Academy of Science* 53(2):139-142.
NAL call number: 500 P383
Descriptors: social behavior, dominance, hierarchy, aggression.

Brooks, D.L., W. Huls, C. Leamon, J. Thomson, J. Parker, and S. Twomey (May 1993). **Cage enrichment for female New Zealand White rabbits.** *Lab Animal* 22(5):30-38.
NAL call number: QL55 A1L33
Descriptors: paired housing, single housing, enrichment objects, behavior, social contact, activity, PVC pipe.

Broom, D.M. (July 1988). **The scientific assessment of animal welfare.** *Applied Animal Behaviour Science* 20(1):5-19.
NAL call number: QL750 A6
Descriptors: welfare, stimuli, preference-test, environment, indicators, behavior, physiology.

Cone, D.M. and A.L. Cone (1970). **Cage activity in cottontail rabbits.** *Psychonomic Science* 21(5):259-260.
Descriptors: photoperiod, illumination, behavior, resting periods, time of day, cage.

Dantzer, R. (June 1986). **Behavioral, physiological and functional aspects of stereotyped behavior: A review and re-interpretation.** *Journal of Animal Science* 62(6):1776-1786.
NAL call number: 49 J82
Descriptors: stereotypy, environment, behavioral repertoire, behavior, endogenous brain opioid peptides, catecholamine, neurotransmitter, dopamine, norepinephrine.

Denenberg, V.H., M.V. Wyly, J.K. Burns, and M.X. Zarrow (June 1973). **Behavioral effects of handling rabbits in infancy.** *Physiology and Behavior* 10(6):1001-1004.
NAL call number: QP1 P4
Descriptors: psychology, social activity, nesting, housing, genetics, maternal care, infancy, handling.

Denenberg, V.H., D. DeSantis, S. Waite, and E.B. Thoman (April 1977). **The effects of handling in infancy on behavioral states in the rabbit.** *Physiology and Behavior* 18(4):553-557.
NAL call number: QP1 P4
Descriptors: resting behavior, daily activity, physiological effects, sleep, infancy, handling.

DeSantis, D., S. Waite, E.B. Thoman, and V.H. Denenberg (October 1977). **Effects of isolation rearing upon behavioral state organization and growth in the rabbit.** *Behavioral Biology* 21(2):273-285.
NAL call number: QH301 C63
Descriptors: feeding behavior, sleeping behavior, locomotor activity, social stimulation, isolation.

Ewbank, R. (1969). **Behavioural implications of intensive animal husbandry.** *Outlook on Agriculture* 6(1):41-46.
NAL call number: 10 Ou8
Descriptors: productivity, behavior, diet, environment, confinement, population density, selective breeding.

Falk, S.A. (October 1973). **Letter: Environmental noise**. *American Journal of Public Health* 63(10):833-836.
NAL call number: 449.9 Am3J
Descriptors: rabbits, acoustic stimulus, stressors, sleep, behavior, environmental noise.

Farabollini, F. (1987). **Behavioral and endocrine aspects of dominance and submission in male rabbits**. *Aggression and Behavior* 13(5):247-258.
Descriptors: social behavior, testosterone, estradiol, androstenedione, corticotropin, dominance, submission.

Farabollini, F., M.E. Albonetti, and F. Dessi-Fulgheri (1991). **Response to intruders in female rabbit colonies is related to sex of intruder and rank of residents.** *Behavioural Processes* 24(2):111-122.
NAL call number: QL750 B4
Descriptors: housing, behavior, agonism, dominance, social behavior, intruder, rank.

Farabollini, F., G. Giordano, and G. Carli (December 1988). **Tonic pain and social behavior in male rabbits.** *Behavior and Brain Research* 31(2):169-175.
Descriptors: dominance, intermale activity, tonic pain, social behavior.

Finzi, A. and L. Gualterio (1990). **Rabbit behaviour in communal nest boxes. [Nidi in comune nell'etologia cunicola.]** *Rivista di Coniglicoltura* 27(3):29-31.
NAL call number: SF451 R5
Descriptors: colony cage, nesting, breeding, social interactions, productivity, paddock system, communal nest box.

Fox, M.W. (1971). **Environmental influences on behavior of domesticated and laboratory animals.** *Advances in Veterinary Science and Comparative Medicine* 15:47-65.
NAL call number: 41.8 Ad9
Descriptors: management, psychological needs, environmental enrichment, age, trauma, stress, exploratory activity.

Harkness, J.E. (1988). **Rabbit behavior as related to environmental stress.** *Journal of Applied Rabbit Research* 11(3):227-236.
NAL call number: QL737 L32J6
Descriptors: ambient temperature, photoperiod, spatial needs, stress, social behavior, acoustic environment.

Hart, L.A. (1994). **Opportunities for environmental enrichment in the laboratory.** *Lab Animal* 23(2):24-27.
NAL call number: QL55 A1L33
Descriptors: rats, rabbits, reptiles, zoo animals, farm animals, noise, housing, caging, burrows, nesting materials, social groups.

Heath, M. and E. Scott (1990). **Housing rabbits the unconventional way.** *Animal Technology: Journal of the Institute of Animal Technology* 41(1):13-26.
NAL call number: QL55 I5
Descriptors: social behavior, floorpen, cage, feeding, exercise, groups.

Horton, B.J., S.D. Turley, and C.E. West (December 1974). **Diurnal variation in the feeding pattern of rabbits.** *Life Sciences* 15(11):1895-1907.
NAL call number: QH301.L54
Descriptors: caging, genetics, behavior, illumination, physiological response, diurnal.

Hudson, R. and T. Vodermayer (February 1992). **Spontaneous and odor-induced chin marking in domestic female rabbits.** *Animal Behaviour* 43(pt.2):329-336.
NAL call number: 410 B77
Descriptors: bricks, oestrus, sexual display, chemosignals, chin marking, photoperiod.

Huls, W.L., D.L. Brooks, and D. Bean-Knudsen (December 1991). **Response of adult New Zealand White rabbits to enrichment objects and paired housing.** *Laboratory Animal Science* 41(6):609-612.
NAL call number: 410.9 P94
Descriptors: caging, females, pairs, chewing behaviors, preference, single housing, enrichment objects.

Jackson, G. (September 1991). **Intestinal stasis and rupture in rabbits.** *The Veterinary Record: Journal of the British Veterinary Association* 129(13):287-289.
NAL call number: 41.8 V641
Descriptors: intestinal stasis, intestinal rupture, handling, stress.

Jilge, B. (1991). **The rabbit: A diurnal or a nocturnal animal?** *Journal of Experimental Animal Science* 34(5-6):170-183.
NAL call number: QL1 J687
Descriptors: chronobiology, locomotor activity, food intake, water consumption, defecation, noise, feed restriction, diurnal, nocturnal.

Khabibulov, M.A. and V.P. Chikunova (1975). **Effect on rabbits of different management systems (housing vs. outside cages).** *Veterinariya* (No. 1):29-31.
Descriptors: husbandry, production, pens, manage, management systems, housing, cage.

Kraft, R. (1979). **Comparative ethology of domestic and wild rabbits. Part 1: Behavior inventory of wild and domestic rabbits.** *Zeitschrift für Tierzuechtung und Zuechtungsbiologie* 95(2):140-162.
Descriptors: domestication, defense, locomotion, social display, wild, ethology.

Kraft, R. (1979). **Comparative ethology of domestic and wild rabbits. Part 2: Quantitative observation on social behavior.** *Zeitschrift für Tierzuechtung und Zuechtungsbiologie* 95(3-4):165-179.
Descriptors: aggression, sexual behavior, affiliative behavior, chinning, ethology, domestic, wild.

Kraft, R. (1979). **Comparative studies of behaviour in wild and domestic rabbits. I. Behavioural inventory. [Vergleichende verhaltensstudien an wild und hauskaninchen. I. Das verhaltensinventar von wild und hauskaninchen.]** *Zeitschrift für Tierzuchtung und Zuchtungsbiologie.* 95(2):140-141.
NAL call number: SF105 A1F6
Descriptors: social activity, dominance, breeding, spatial behavior, wild.

Kryter, K.D. (March 1972). **Non-auditory effects of environmental noise.** *American Journal of Public Health* 62(3):389-398.
Descriptors: threshold, psychology, adaptation, infarction, environmental noise.

Lefevre, B. and B. Moret (1978). **Effect of sudden environmental change on the onset of estrus in nulliparous rabbits.** *Annales de Biologie Animale Biochimie Biophysique* 18(3):695-698.
NAL call number: 442.8 AN75
Descriptors: photoperiod, handling, exposure to male, individual cages, stress, environmental change, estrus, nulliparous.

Lehmann, M. (November 1991). **Social behavior in young domestic rabbits under semi-natural conditions.** *Applied Animal Behaviour Science* 32(2-3):269-292.
NAL call number: QL750.A6
Descriptors: feeding, locomotor activity, exploration, spatial behavior, social.

Lindemann, H. (1978). **Behavioural habits as values for studying the well-being of domestic rabbits. [Verhaltensweisen als parameter für das wohlbefinden von hauskaninchen.]** In: *Aktuelle Arbeiten zur artgemassen Tierhaltung* F. Lachenmaier and M.C. Schlichting, eds., Kuratorium für Technik und Bauwesen in der Landwirtschaft: German Federal Republic, pp. 84-92.
NAL call number: 18 K96 No. 233
Descriptors: housing, cages, floor pens, husbandry, social behavior.

Loeffler, K., B. Drescher, and G. Schulze (1991). **Effects of different housing systems on the behaviour in Chinchilla-Bastard-Experimental and New Zealand White rabbits. Part I. [Einfluss unterschiedlicher haltungsverfahren auf das Verhalten von versuchs und fleischkaninchen. I. Mitteilung.]** *Tierärztliche Umschau* 46(8):471-478.
NAL call number: 41.8 T445
Descriptors: wire-floor, cages, straw bedding, feeding, locomotion, nest building, circadian activity, housing.

Love, J.A. (February1994). **Group housing: Meeting the physical and social needs of the laboratory rabbit.** *Laboratory Animal Science* 44(1):5-11.
NAL call number: 410.9 P94
Descriptors: group housing, single caging, group sizes, management, space allocation, diet, stress, stereotypy, behavior, activity, disease, economic guidelines.

Love, J.A. and K. Hammond (September 1991). **Group-housing rabbits.** *Lab Animal* 20(8):37-43.
NAL call number: QL55 A1L33
Descriptors: group housing, single caging, welfare, cage space, behavior, management, disease.

Luzi, F., E. Heinzl, and C. Crimella (1990). **Effects of transport on some measures of production in rabbits. [Influenza del transporto su alcuni parametri produttivi nella specie cunicola.]** *Rivista di Coniglicoltura* 27(6):37-40.
NAL call number: SF451 R5
Descriptors: season, ambient temperature, plastic cages, stress, travel, transport.

Milligan, S.R., G.D. Sales, and K. Khirnykh (1993). **Sound levels in rooms housing laboratory animals: An uncontrolled daily variable.** *Physiology and Behavior* 53(6):1067-1076.
NAL call number: QP1 P4
Descriptors: noise, stress, rabbits, rodents, ultrasound, ferrets.

Morton, D. (1994). **Enrichment techniques for rodents and rabbits.** In: *Rodents and Rabbits: Current Research Issues,* S.M. Niemi, J.S. Venable, and H.N. Guttman, eds., Scientists Center for Animal Welfare: Greenbelt, MD and WARDS: Washington, DC, pp. 20-27.
Descriptors: group housing, behavior, economics, noise, labor.

Morton, D.B., M. Jennings, G.R. Batchelor, D. Bell, L. Birke, K. Davies, J.R. Eveleigh, D. Gunn, M. Heath, B. Howard, P. Koder, J. Phillips, T. Poole, A.W. Sainsbury, G.D. Sales, D.J.A. Smith, M. Stauffacher, and R.J. Turner (October 1993). **Refinements in rabbit husbandry: Second report of the BVAAWF/FRAME/ RSPCA/UFAW Joint working group on refinement.** *Laboratory Animals* 27(4):301-329.
NAL call number: QL55 A1L3
Descriptors: welfare, husbandry, housing, density, environmental enrichment, breeding, health, costs, cage, lighting, natural behavior, stereotyped behavior, temperature, humidity, ventilation, handling, bedding, food.

Muller, H.A. and H. Brummer (1981). **Reproductive behaviour and fertility of rabbits kept individually or in groups. [Untersuchungen uber fortpflanzungsverhalten und fertilitat des hauskaninchens in einzel und in gruppenhaltung.]** *Tierärztliche Umschau* 36(11):763-767.
NAL call number: 41.8 T44S
Descriptors: breeds, housing, litter size, behavior, reproductive behavior, fertility.

Nayfield, K.C. and E.L. Beach (1981). **Comparative responses of rabbits and rats to elevated noise.** *Laboratory Animal Science* 31(4):386-390.
NAL call number: 410.9 P94
Descriptors: rabbits, rats, noise, behavior.

Olfert, E.D., B.M. Cross, and A.A. McWilliam, eds. (1993). **VI. Social and behavioural requirements of experimental animals: G. Rodents and rabbits.** In: *Guide to the Care and Use of Experimental Animals (2nd ed.)* Canadian Council on Animal Care: Ottawa, Ontario. 1:70-88.
NAL call number: SF406 G85 1993
Descriptors: social behavior, enrichment devices, caging and bedding, environmental control.

Paatashvili, K.A., N. Ya. Kravchenko, and B.S. Babayants (1978). **Battery system for laboratory rabbits.** *Veterinariya* (No. 9):100-101.
Descriptors: cages, housing, husbandry.

Podberscek, A.L., J.K. Blackshaw, and A.W. Beattie (1991). **The behavior of group penned and individually caged laboratory rabbits.** *Applied Animal Behaviour Science* 28(4):353-364.
NAL call number: QL750 A6
Descriptors: genetics, maintenance behavior, locomotion, comfort, investigatory behavior, stereotypes.

Podberscek, A.L., J.K. Blackshaw, and A.W. Beattie (1991). **The effects of repeated handling by familiar and unfamiliar people on rabbits in individual cages and group pens.** *Applied Animal Behaviour Science* 28(4):365-374.
NAL call number: QL750 A6
Descriptors: rabbit-human interaction, fear, habituation, housing, handling, familiarity.

Rabillard, J.L. (1985). **The behavior of rabbits during breeding and experimentation.** *Stal Sciences et Techniques de l'Animal de Laboratoire* 10(3):209-212.
Descriptors: Aggressive behavior, litters, stress, human interaction, breeding, experimentation.

Rothfritz, P., K. Loeffler, and B. Drescher (October 1992). **The effects of different housing systems on the structure of cancellous bones of Chinchilla and New Zealand White rabbits.** *Tierärztliche Umschau* 47(10):758.
NAL call number: 41.8 T445
Descriptors: movement, vertebrae, hypoplasia, cages, housing, cancellous bone.

Rothfritz, P., K. Loeffler, and B. Drescher (1992). **Effect of housing and exercise on the structure of spongy bone of the ribs, thoracic vertebrae and lumbar vertebrae of laboratory and broiler rabbits. IV. [Einfluss unterschiedlicher haltungsverfahren und bewegungsmoglichkeiten auf die spongiosastruktur der rippen sowie brust und lendenwirbel von versuchs und fleischkaninchen. 4. Mittelung.]** *Tierärztliche Umschau* 47(10):758-768.
NAL call number: 41.8 T445
Descriptors: cage size, hypoplasia, husbandry, welfare, housing, exercise, spongy bone.

Sandford, J.C. (1986). *The Domestic Rabbit.* Collins Professional and Technical: London, UK, 272 p.
NAL call number: SF453 S33 1986
Descriptors: housing, breeding, equipment, industry, genetics.

Scholtyssek, S. and K. Eissele (1986). **Keeping rabbits at different housing densities. [Die haltung von kaninchen in unterschiedlicher besatzdichte.]** *Zuchtungskunde* 58(2):142-147.
NAL call number: 49 Z8
Descriptors: housing, food consumption, crowding, weight gain, density.

Stauffacher, M. (1992). **Group housing and enrichment cages for breeding, fattening, and laboratory rabbits.** *Animal Welfare* 1:105-125.
NAL call number: HV4701.A557
Descriptors: legislation, welfare, breeding, single cages, paired housing, near-to-nature conditions, pup area, nesting area, commercial housing, social groups, spatial conditions.

Stauffacher, M. (1992). **Rabbit breeding and animal welfare: New housing concepts for laboratory and fattening rabbits.** *DTW (Deutsche Tieraerztliche Wochenschrift)* 99(1):9-15.
NAL call number: 41.8 D482
Descriptors: breeding groups, caging, legislation, behavior, welfare, housing, floor area, stereotypies, sexual behavior, breeding.

Stavy, M., A. Goldblatt, and J. Terkel (March 1985). **Home odor preferences in young hares *(Lepus capensis syriacus)*: Effects of age and role of maternal presence.** *Developmental Psychobiology* 18(2):125-139.
NAL call number: QP351 D4
Descriptors: home cage odor, strange cage odor, preference testing, avoidance, age, social relationships, maternal presence.

Vastrade, F.M. (1987). **Spacing behavior of free-ranging domestic rabbits (*Oryctolagus cuniculus*).** *Applied Animal Behaviour Science* 18(2):185-196.
NAL call number: QL750 A6
Descriptors: social relationships, colony management, distance, husbandry, behavior, free-range, spacing behavior.

Whary, M., R. Peper, G. Borkowski, W. Lawrence, and F. Ferguson (March 1993). **The effects of group housing on the research use of the laboratory rabbit.** *Laboratory Animals* 27:330-341.
NAL call number: QL55 A1L3
Descriptors: exercise, social contact, group housing, single housing, environmental enrichment, behavior.

Wyly, M.V., V.H. Denenberg, D. DeSantis, J. K. Burns, and M.X. Zarrow (March 1975). **Handling rabbits in infancy: In search of a critical period.** *Developmental Psychobiology* 8(2):179-186.
NAL call number: QP351 D4
Descriptors: psychology, social activity, exploratory activity, open-field test, handling, infancy.

Rodents

ENVIRONMENTAL ENRICHMENT IN RODENTS

Heleen A. van de Weerd and Vera Baumans
Department of Laboratory Animal Science,
Utrecht University, P.O. Box 80.166, 3508 TD Utrecht
The Netherlands

Environments of laboratory animals have often been designed on the basis of economic and ergonomic aspects, with little or no consideration for animal welfare. Laboratory housing conditions can deprive animals the possibility of performing a full repertoire of normal behavior. As a response to this lack of stimulation animals may show abnormal behaviors, such as stereotypies or passiveness (Wemelsfelder 1990).

The living conditions and therefore the well-being of captive animals can be improved through environmental enrichment. Environmental enrichment can be defined as altering the living environment of captive animals in order to provide opportunities to express more of their natural behavioral repertoire. It is widely acknowledged that allowing animals to perform the widest possible range of behaviors is likely to be beneficial and, furthermore, providing environmental enrichment has been shown to reduce stereotypic behavior in captivity (e.g., bank voles: Ödberg 1987).

The environment of an animal consists of a wide range of stimuli, including the social environment of conspecifics, contraspecifics and humans, and the physical environment such as the cage and its contents (See Figure 1). Currently used caging for rodents restricts various behaviors (O' Donoghue 1993) and it is recommended that the cage environment should be improved to cater for physiological and ethological "needs" including resting, grooming, exploring, hiding, searching for food, and gnawing.

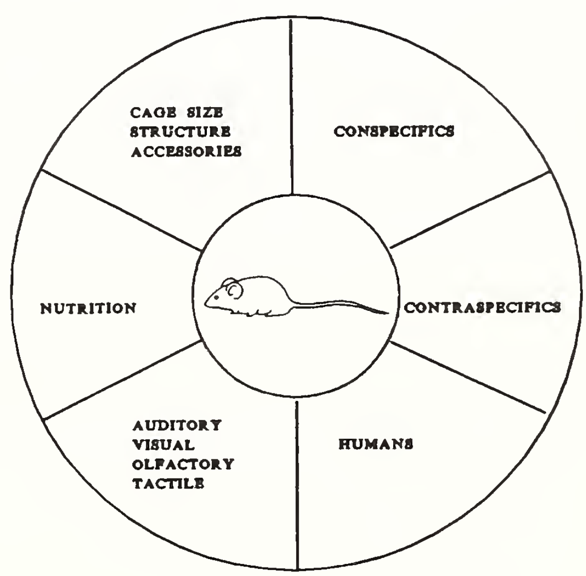

Figure 1. Stimuli in the environment of laboratory animals (Baumans 1994).

Social environment

Conspecifics, contraspecifics, and humans

The social environment of animals can be enriched by housing them together with conspecifics in pairs or in groups. This will only be successful if the groups or pairs formed are harmonious and stable. Mice and rats are social animals and often housed in groups, although this is not a natural situation for the males. In some strains, especially in mice, aggression may be a problem and the males need to be separated. In contrast, hamsters are not social, which eventually can lead to problems when housing such animals together.

Housing together several animal species in the same room is often common practice. It is not known whether contraspecifics housed in one animal room are affected by the olfactory and auditory cues from each other. Humans are part of the social environment of laboratory animals and handling the animals is a very important aspect of this daily care routine. It is also beneficial to train animals to become used to routine handling and procedures (Biological Council 1992).

Nutritional environment

Supply and type

In the wild, rodents spend a major proportion of their time searching for and consuming food. In the laboratory food is mostly provided *ad libitum* and easily obtained by the animals. For enrichment purposes food items can be scattered in the substrate or bedding so that the animals spend time searching for it. Carder and Berkowitz (1970) found that rats preferred earned food although free food was available, when the work demands were not too high . For hamsters who naturally hoard their food, scattering food pellets into the cage is an easy source of stimulation.

The type of food given to laboratory animals is usually standardized in the form of pellets but additional food such as hay or straw can be supplied to satisfy the need for roughage.

Sensory environment

Auditory, visual, olfactory and tactile

Sensory enrichment can be provided in many forms. Animals such as guinea pigs, which are easily frightened, react to noises in their environment; a radio which plays softly during the day can mask sudden background noises.

In many animal facilities, light intensity is usually too high. This may have deleterious effects on eyes such as retinal degeneration (Williams *et al.* 1985), especially in albinos. Rodents, who are essentially nocturnal animals, should be given the opportunity to hide from light.

Psychological environment

Control of the environment

It is important that animals have a certain degree of control over their environment, as a lack of control may cause stress. Rats reared in an environment in which they could control lighting, food and water supply were less emotional compared to controls (Joffe *et al.* 1973). In the laboratory cage the possibilities for animals to control their environment are restricted. However providing a shelter or refuge gives them the opportunity to withdraw from frightening stimuli outside or inside their cage as well as hide from too much light. Plastic tubes (Peters and Festing 1990) or old drinking bottles (Ward and DeMille 1991) are simple solutions for shelters.

Physical environment

Cage size, structure and accessories

Sometimes enlarging the available space for an animal can enhance well-being. Small cages may increase the incidence of stereotyped movements and other non-locomotor abnormal behaviors (Ödberg 1987). Enlarging the available space can be achieved by providing climbing accessories, shelters/refuges and exercise devices. When mice were given a divided cage with a bedding section and a wire mesh section, they deposited almost all excreta on the wire mesh floor, thus keeping their sleeping area clean (Blom 1993).

Nesting material such as tissues, hay or wood-wool enables rodents to perform nest-building behavior. Softwood sticks can be provided to guinea pigs for manipulation and gnawing (Sharmann 1991).

Evaluation of an enrichment program

When introducing enrichment to an animal's environment, it is very important to evaluate the enrichment program used, by assessing whether or not the animals respond to the enrichment and maintain interest.

Assess baseline behavior; introduce enrichment; monitor behavior; analyze responses; long term effects

Reactions of the animals to the enrichment should be monitored and compared with baseline behavior, which was assessed before introduction of enrichment. An increase in species-typical behavior or a decrease in abnormal behavior may be seen. Different strains of animals can respond differently to enrichment as has been observed in mice (van de Weerd *et al.* 1994). It is also important to assess whether the changes in behavior are short or long term effects, as the animals may be interested in the enrichment for a short period only. Physiological variables can also be monitored to assess responses to changes in laboratory environments, e.g., body-weight, heart rate, hormonal levels, immune status and reproductive function (Markowitz and Line 1990).

When introducing enrichment in the laboratory, costs and the practical use of enrichment items are also important. Objects introduced into the cage should be stimulating for the animals, but they should also be easy to remove, clean, and replace, so that personnel are willing to work with them. If it is clear to those responsible for animals that environmental enrichment is beneficial to the animals, their motivation to work with and to improve the enrichment program should increase.

References

Baumans, V. (1994). **Husbandry and welfare of laboratory rodents and rabbits: the relevance of behavioural studies.** In: *Welfare and Science.* Proceedings of the 5th FELASA symposium, J. Bunyan, ed., Royal Society of Medicine Press: London, pp.65-67.

Biological Council (1992). ***Guidelines on the Handling and Training of Laboratory Animals***. UFAW: Potters Bar, England.

Blom, H.J.M. (1993). **Evaluation of housing conditions for laboratory mice and rats.** Ph.D Thesis, Utrecht University: The Netherlands, pp. 81-99.

Carder, B. and K. Berkowitz (1970). **Rats' preference for earned food in comparison with free food.** *Science* 169:1273-1274.

Joffe, J.M., R.A. Rawson, and J.A. Mulick (1973). **Control of their environment reduces emotionality in rats**. *Science* 180:1383-1384.

Markowitz, H. and S. Line (1990). **The need for responsive environments.** In: *The Experimental Animal in Biomedical Research, vol I.*, B.E. Rollin, ed., CRC Press: Florida, pp. 153-170.

Ödberg, F.O. (1987). **The influence of cage size and environmental enrichment on the development of stereotypies in bank voles *(Clethrionomys glareolus)*** *Behavioural Processes* 14:155-173.

O' Donoghue, P.N. (1993). ***The Accommodation of Laboratory Animals in Accordance with Animal Welfare Requirements***. Proceedings of an international workshop, Berlin 1993.

Peters, A. and M. Festing (1990). **Population density and growth rate in laboratory mice.** *Laboratory Animals* 24:273-279.

Sharmann, W. (1991). **Improved housing of mice, rats and guinea-pigs: A contribution to the refinement of animal experiments.** *ATLA* 19:108-114.

van de Weerd, H. A., V. Baumans, J.M. Koolhaas, and L.F.M. van Zutphen (August 1994). **Strain specific behavioural response to environmental enrichment in the mouse.** *Journal of Experimental Animal Science*. 36(4-5):117-127.

Ward, G.E. and DeMille, D. (1991). **Environmental enrichment for laboratory mice (*Mus musculus*).** *Animal Technology: Journal of the Institute of Animal Technology* 42(3):149-156.

Wemelsfelder, F. (1990). **Boredom and laboratory animal welfare.** In: *The Experimental Animal in Biomedical Research, vol I,* B.E.Rolin, ed., CRC Press: Florida, pp. 243-272.

Williams, R.A., A.G. Howard, and T.P. Williams (1985). **Retina damage in pigmented and albino rats exposed to low levels of cyclic light following a single mydriatic treatment.** *Current Eye Research* 4(2):97-102.

RODENT BIBLIOGRAPHY

GERBILS AND HAMSTERS

Arnold, C. and S. Gillaspy (1994). **Assessing laboratory life for golden hamsters: Social preference, caging selection, and human interaction.** *Lab Animal* 23(4):34-37.
NAL call number: QL55 A1L33
Descriptors: hamster, Golden, male, socialization, solitary nature, caging, Habitrail tunnels, bedding, handling, group housing.

Borer, K.T., A. Pryor, C.A. Conn, R. Bonna, and M. Kielb (1988). **Group housing accelerates growth and induces obesity in adult hamsters.** *American Journal of Physiology* 255(1 pt.2):R128-R133.
NAL call number: 447.8 Am3
Descriptors: hamster, Golden, female, adult, isolation, socially reared, bedding, body weight, body fat.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Cheal, M.L. (1987). **Environmental enrichment facilitates foraging behavior.** *Physiology and Behavior* 39(2):281-283.
NAL call number: QP1 P4
Descriptors: gerbil, adult, old, locomotor activity, outdoor experience vs. laboratory rearing, novel objects, odors, food.

Cheal, M.L. (1987). **Lifespan environmental influences on species typical behavior of *Meriones unguiculatus*.** In: *Evolution of Longevity in Mammals. A Comparative Approach,* A.D. Woodhead and K.H. Thompson, eds. Plenum Press: New York, NY, pp.145-159.
NAL call number: QP85 B73
Descriptors: gerbil, body weight, lifespan, behavior.

Cheal, M.L., K. Foley, and R. Kastenbaum (1986). **Brief periods of environmental enrichment facilitate adolescent development of gerbils.** *Physiology and Behavior* 36(6):1047-1051.
NAL call number: QP1 P4
Descriptors: gerbil, male, female, motor behavior, somatic growth, seizures, indoor vs. outdoor.

Fischer, R.B. and P.S. Brown (1993). **Vaginal secretions increase the likelihood of intermale aggression in Syrian hamsters.** *Physiology and Behavior* 54(2):213-214.
NAL call number: QP1 P4
Descriptors: hamster, male, female, social environment, vaginal odors.

Hsu, C.H. and C.S. Carter (1986). **Social isolation inhibits male-like sexual behavior in female hamsters.** *Behavioral and Neural Biology* 46: 242-247.
NAL call number: QH301 C63
Descriptors: hamster, Golden, female, group housing, weaning age.

Hull, E.M., C. Kastaniotis, G. L'Hommedieu, and J. Franz (1976). **Environmental enrichment and crowding: Behavioral and hormonal effects.** *Physiology and Behavior* 17(5):735-741.
NAL call number: QP1 P4
Descriptors: gerbil, male, female, weanling, adult, crowding, social interaction, cortisol, testosterone, testes weight, adrenal weight, behavior, reproduction.

Martin-Ramirez, J. and D.I. Onyekwere (1993). **Play fighting in Golden Syrian hamsters: Influence of age, sex, and social isolation.** *Aggressive Behavior* 19(1):65-66.
NAL call number: BF575 A3A57
Descriptors: hamster, Golden Syrian, male, isolation, play.

McClure, D.E. and J.L. Thomson (1992). **Cage enrichment for hamsters housed in suspended wire cages**. *Contemporary Topics* 31(4):33 (abstract).
NAL call number: SF405.5 A23
Descriptors: hamster, aggression, anorexia, cotton nestlets, wire cages, PVC pipe, toys, seclusion.

Norris, M.L. and C.E. Adams (1979). **Vaginal opening in the Mongolian gerbil, *Meriones unguiculatus*: Normal data and the influence of social factors.** *Laboratory Animals* 13(2):159-162.
NAL call number: QL55 A1L3
Descriptors: gerbil, male, female, cage density, body weight, vaginal opening, age.

Onyekwere, D.I. and J.M. Ramirez (1993). **Play fighting versus serious fighting in golden hamsters (*Mesocricetus auratus*).** *Bulletin of the Psychonomic Society* 31(6):503-506.
Descriptors: hamster, Golden, young, isolation, aggression.

Pellis, S.M. and V.C. Pellis (1993). **Influence of dominance on the development of play fighting in pairs of male Syrian Golden hamsters--*Mesocricetus auratus*.** *Aggressive Behavior* 19(44):293-302.
NAL call number: BF575 A3A57
Descriptors: hamster, Syrian Golden, male, weanling, young, adult, aggression, submission, play, rat.

Tang-Martinez, Z., L.L. Mueller, and G.T. Taylor (1993). **Individual odors and mating success in the golden hamster, *Mesocrecitus auratus*.** *Animal Behaviour* 45(6):1141-1151.
NAL call number: 410 B77
Descriptors: hamster, Golden, female, male, olfaction, pheromones, litter size, pregnancy rate.

Thomas, E.M., M.E. Jewett, and I. Zucker (1993). **Torpor shortens the period of Siberian hamster circadian rhythms.** *American Journal of Physiology: Regulatory, Integrative and Comparative Physiology* 265(4):R951-R956.
NAL call number: 447.8 Am3
Descriptors: hamster, Siberian, male, ambient temperature, body temperature, gonadectomized, running wheel, body mass.

Van den Broek, F.A.R., H. Klompmaker, R. Bakker, and A.C. Beynen (May 1995). **Gerbils prefer partially darkened cages.** *Animal Welfare* 4(2): 119-123.
NAL call number: HV4701 A557
Descriptors: housing, preference test, light intensity, Mongolian gerbils.

GUINEA PIGS

Bailey, K.J., D.B. Stephens, and C.E. Delaney (1986). **Observations on the effects of vibration and noise on plasma ACTH and zinc levels, pregnancy and respiration rate in the guinea pig.** *Laboratory Animals* 20: 101-108.
NAL call number: QL55 A1L3
Descriptors: guinea pig, female, pregnant, nonpregnant, transport simulator, ACTH, zinc.

Berryman, J.C. (1981). **Guinea pig responses to conspecific vocalizations: Playback experiments.** *Behavioral and Neural Biology* 31(4):476-482.
NAL call number: QH301 C63
Descriptors: guinea pig, female, neonate, lactating, virgin, behavior, silence, nonvocal sounds, communication, maternal behavior.

Berryman, J.C. (1978). **Social behaviour in a colony of domestic guinea pigs: Aggression and dominance.** *Zeitschrift für Tierpsychologie* 46(2):200-214.
NAL call number: 410 Z35
Descriptors: guinea pig, male, female, behavior, activity, social group, dominance, aggression, vocal communication.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Coulon, J. (1971). **Influence of social isolation on the behavior of guinea pigs (Influence de l'isolement social sur le comportement du cobaye.** *Behaviour* 38(1-2):93-120.
NAL call number: 410 B393
Descriptors: guinea pig, male, female, isolation, maternal care, exploratory behavior, activity, play, open-field behavior.

Coulon, J. (1973). **Social relationships of domestic male guinea pigs. 2. The agonistic behavior on their territory. [Les relations sociales chez le cobaye domestique male. II. Le comportement agonistique interterritorial.]** *Behaviour* 53(3-4):200-216.
NAL call number: 410 B393
Descriptors: guinea pig, male, dominance, aggression, behavior, territory.

Dayal, V.S. and J.K. Bhattacharyya (1986). **Cochlear hair cell damage from intermittent noise exposure in young and adult guinea pigs.** *American Journal of Otolaryngology* 7: 294-297.
Descriptors: guinea pig, male, female, weanling, adult, auditory stimuli.

Hennessy, M.B. and L. Moorman (1989). **Factors influencing cortisol and behavioral responses to maternal separation in guinea pigs.** *Behavioral Neursoscience* 103(2):378-385.
NAL call number: QP351 B45
Descriptors: guinea pigs, male, female, maternal separation, isolation, cortisol, inanimate surrogates.

Plank, S.J. and R. Irwin (1966). **Infertility of guinea pigs on sawdust bedding.** *Laboratory Animal Care* 16(1):9-11.
NAL call number: 410.9 P94
Descriptors: guinea pig, male, female, reproduction, bedding.

Pye, A. (1987). **Comparison of various short noise exposures in albino and pigmented guinea pigs.** *Archives of Oto-Rhino-Laryngology* 243: 411-416.
Descriptors: guinea pigs, noise.

Sascher, N. (1986). **The effects of longterm isolation on physiology and behavior in male guinea pigs.** *Physiology and Behavior* 38: 31-39.
NAL call number: QP1 P4
Descriptors: guinea pig, male, female, isolation, group-housed, body weight, tyrosine hydroxylase, activity, aggression.

White, W.J., M.W. Balk, and C.M. Lang (1989). **Use of cage space by guinea pigs.** *Laboratory Animals* 23: 208-214.
NAL call number: QL55 A1L3
Descriptors: guinea pig, male, female, spatial behavior, caging, activity.

MICE

Ahroon, J.K. (1977). **The effects of environmental switchovers between enrichment and impoverishment on brain and behavior in mice.** *Dissertation Abstracts International* 37(7-B):3668.
NAL call number: Z5055.U49 D53
Descriptors: mouse, environmental enrichment, impoverishment, open field, activity.

Ardila, R., M. Rezk, R. Polanco, and F. Pereira (1977). **Early handling, electric shock, and environmental complexity: Effects on exploratory behavior, "emotionality," and body weight.** *Psychological Record* 27(1):219-224.
Descriptors: mouse, Swiss, aversive stimuli, environmental enrichment, darkness, handling, open field, defecation, activity.

Bartos, L. and P.F. Brain (1993). **Physiological responses to social status and housing conditions in male mice subject to food competition tests.** *Bollettino di Zoologia* 60(3):293-296.
NAL call number: 410 B63
Descriptors: mouse, male, testes, prostate, adrenal gland, stress.

Baumans, V., F.R. Stafleu, and J. Bouw (1987). **Testing housing system for mice-the value of a preference test.** *Zeitschrift für Versuchstierkunde* 29:9-14.
NAL call number: 410 Z36
Descriptors: mouse, female, caging, preference testing, shelter.

Beynan, A.C. and G. Van Tintelen (1990). **Daily change of cage depresses mass gain in mice.** *Zeitschrift für Versuchstierkunde* 33:106-107.
NAL call number: 410 Z36
Descriptors: mouse, male, female, cage changing, weight gain, activity.

Boehm, G.W., N.S. Waters, G.F. Sherman, G.D. Rosen, D.M. Bradway, B.J. Hoplight, A.M. Galaburda, and V.H. Denenberg (1993). **Environmental enrichment, neocortical ectopias and behavior in BXSB mice.** *Society for Neuroscience Abstracts* 19(1-3):184.
NAL call number: QP351 S6
Descriptors: mouse, learning, behavior.

Bouchon, R. and B. Will (1982). **Effects of post-weaning rearing conditions on learning performance in "dwarf" mice. [Effets des conditions d'elevage apres le sevrage sur les performances d'apprentissage des souris "dwarf."]** *Physiology and Behavior* 28(6):971-978.
NAL call number: QP1 P4
Descriptors: mouse, dwarf, locomotor activity, learning.

Bouchon, R. and B. Will (1982). **Effects of early enriched and restricted environments on the exploratory and locomotor activity of dwarf mice.** *Behavioral and Neural Biology* 35(2):174-186.
NAL call number: QH301 C63
Descriptors: mouse, weanling, dwarf, open-field, habituation, behavior.

Bouchon, R. and B. Will (1983). **Effects of post-weaning environment and apparatus dimension on spontaneous alternation as a function of phenotype in "dwarf" mice.** *Physiology and Behavior* 30(2):213-219.
NAL call number: QP1 P4
Descriptors: mouse, DW/Orl-dw, inbred strain, male, maze, spatial information, behavior.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Brain, P. (1975). **What does individual housing mean to a mouse?** *Life Sciences* 16(2):187-200.
NAL call number: 442.8 L62
Descriptors: mouse, isolation, caging, socially reared, adrenal medullary function, adenocortical function, reproduction, neurochemistry, defeat experiments, review.

Bronson, F.H. (1984). **The adaptability of the house mouse.** *Scientific American* March: 116-125.
NAL call number: 470 Sci25
Descriptors: mouse, running wheel, burrow, reproduction, foraging, temperature, social cues, behavior, review.

Chamove, A.S. (1989). **Cage design reduces emotionality in mice.** *Laboratory Animals* 23(3):215-219.
NAL call number: QL55 A1L3
Descriptors: mouse, caging, partitions, activity, stress, adrenal glands, behavior, complexity.

Corridi, P., F. Chiarotti, S. Bigi, and E. Alleva (1993). **Familiarity with conspecific odor and isolation-induced aggressive behavior in male mice *(Mus domesticus)*.** *Journal of Comparative Psychology* 107(3):328-335.
NAL call number: BF671 J6
Descriptors: mouse, Swiss CD-1, isolation, olfaction, agonistic behavior, dominance.

Cummins, R.A., T.N. Carlyon, and R.N. Walsh (1978). **Drug-modulated behavioural responses to environmental enrichment.** *Psychopharmacology* 58(2):197-199.
Descriptors: mouse, Quackenbush albino, male, strychnine, chlorpromazine, activity, socialization.

Cummins, R.A., P.J. Livesey, and J.A. Bell (1982). **Cortical depth changes in enriched and isolated mice.** *Developmental Psychobiology* 15(3):187-195.
NAL call number: QP351 D4
Descriptors: mouse, neonate, weanling, aging, occipital cortex, neuronal development, metabolic activity.

Diaz, J.-L. (1988). **Brain weights correlate with behavioral parameters in individual inbred mice housed in a common and enriched environment.** *Behavioral and Neural Biology* 50(2):164-183.
NAL call number: QH301 C63
Descriptors: mouse, BALB/c, young, maze, open field, exploration, aversive response, swimming, induced grooming, whole brain, cerebellum, brain stem, diencephalon, telencephalon, prosencephalon.

Elliott, R.A. (1970). **Some anatomical and behavioral effects of environmental enrichment on genetically heterogenous mice selectively bred for high and low brain weight.** *Dissertation Abstracts International* 31(4-B):2302-2303.
NAL call number: Z5055.U49D53
Descriptors: mouse, cortex, discrimination tasks.

Engellenner, W.J., C.R. Goodlet, R.G. Burright, and P.J. Donovick (1982). **Environmental enrichment and restriction effects on reactivity, exploration and maze learning in mice with septal lesions.** *Physiology and Behavior* 29(5):885-893.
NAL call number: QP1 P4
Descriptors: mouse, Binghamton, heterogenous, male, handling-reactivity test, open-field, water-maze, learning, behavior.

Erikson, D.J. and T.N. Meacham (1973). **Effects of increased space deprivation on reproductive performance of female ICR-albino mice.** *Publication - Extension Division of Virginia Polytechnic Institute and State University* 153: 56-59.
NAL call number: S543.V5V5
Descriptors: mouse, ICR-albino, female, prebreeding, postbreeding, embryo survival, density, corticosteroids.

Eveleigh, J.R. (1993). **Murine cage density: Cage ammonia levels during the reproductive performance of an inbred strain and two outbred stocks of monogamous breeding pairs of mice.** *Laboratory Animals* 27(2):156-160.
NAL call number: QL55 A1L3
Descriptors: mouse, BALB/c, TO, CD-1, Laboratory Animal Breeders Association Guidelines, housing, male, female, breeding, litter size.

Falke, H.E. and H.P. Til (1985). **Effect of polychlorophenols in sawdust bedding on some biotransformation parameters in the liver of mice.** *Netherlands Journal of Agricultural Science* 33(3):314-316.
NAL call number: 12 N3892
Descriptors: mouse, male, female, weanling, liver weight, P-450 enzymes, polychlorophenols, bedding.

Ferrer, I. et al.. (1983). **Morphological changes in the cerebral cortex of mice subjected to enriched and impoverished environments and its later reversal. [Cambios morfologicos en la corteza cerebral de retones somtidos a medios enriquecidos y a medios empobrecidos en stimulos sensoriales y su posterior recuperacion.]** *Archivos de Neurobiologia* 46(3):177-182.
Descriptors: mouse, visual cortex, maze, neuronal plasticity.

Goodlet, C.R., W.J. Engellenner, R.G. Burright, and P.J. Donovick (1982). **Influence of environmental rearing history and postsurgical environmental change on the septal rage syndrome in mice.** *Physiology and Behavior* 28(6):1077-1081.
NAL call number: QP1 P4
Descriptors: mouse, Binghamton, heterogenous, septal lesions, handling reactions.

Guastavino, J.M. and G. Goodall (1985). **Permanency of gait improvement induced by vestibular stimulation in the mutant mouse staggerer.** *Journal of Neurogenetics* 2(4):273-283.
Descriptors: mouse, behaviorally deficient mutant, environmental enrichment, vestibular, muscular, and visual stimulation.

Gue, M., J. Fiorsmonte, and L. Bueno (1987). **Comparative influences of acoustic and cold stress on gastrointestinal transit in mice.** *American Journal of Physiology* 253(2 pt.1):G124-G128.
NAL call number: 447.8 Am3
Descriptors: mouse, noise, stress, temperature, gastrointestinal transit.

Hastings, I.M. and W.G. Hill (1993). **The effects of cage type on murine body composition.** *Mouse Genome* 91(2):329-330.
NAL call number: QL737 R638M68
Descriptors: mouse, high fat content, plastic vs. aluminum caging.

Henderson, N.D. (1979). **Dominance for large brains in laboratory mice.** *Behavior Genetics* 9(1):45-49.
NAL call number: QH301 B45
Descriptors: mouse, genetic variance, genotype, housing, environmental enrichment.

Hoffman, G.L., J.R. Simpson, and Y. Arumugam (1991). **Impact of changes in housing condition on mouse natural killer cell activity.** *Physiology and Behavior* 49(3):657-660.
NAL call number: QP1 P4
Descriptors: mouse, male, caging, tumors, in vitro, cytolytic activity.

Hurst, J.L., F. Jiming, and C.J. Barnard (1993). **The role of substrate odors in maintaining social tolerance between male house mice, *Mus musculus domesticus*.** *Animal Behaviour* 45(5):997-1006.
NAL call number: 410 B77
Descriptors: mouse, male, bedding, olfaction, isolation, interaction.

Iturrian, W.B. (1971). **Effect of noise in the animal house on experimental seizures and growth of weanling mice.** In: *Defining the Laboratory Animal*, pp. 332-352.
NAL call number: SF406 I52
Descriptors: mouse, age, noise, test interval, seizure-prone, drugs, non-auditory stimuli.

Iturrian, W.B. and G.B. Fink (1968). **Comparison of bedding material: Habitat preference of pregnant mice and reproductive performance.** *Laboratory Animal Care* 18(2):160-164.
NAL call number: 410.9 P94
Descriptors: mouse, female, behavior, cellulose, nesting.

Jacobs, B.B. and D.K. Dieter (1978). **Spontaneous hepatomas in mice inbred from HA-ICR Swiss stock: Effects of sex, cedar shavings in bedding, and immunization with fetal liver or hepatoma cells.** *Journal of the National Cancer Institute* 61(6):1531-1534.
NAL call number: 176.622 J82
Descriptors: mouse, SWJ/Jac, male, female, hepatoma, cedar shavings, bedding.

Jones, R.B. (1992). **Reply to McGregor, Barnard, and Hurst** (see App.Anim.Behav.Sci. 33:297-299). *Applied Animal Behaviour Science* 33:300-301.
Descriptors: mouse, environmental enrichment, impoverished, aggression, caging, animal welfare.

Jones, R.B. (1992). **Varied cages and aggression.** *Applied Animal Behaviour Science* 33(2-3):295-296.
Descriptors: mouse, male, environmental enrichment, standard caging, impoverished, dominance, submission, fighting, olfaction, benefits.

Karp, J.D., J.A. Moynihan, and R. Ader (1993). **Effects of differential housing on the primary and secondary antibody responses of male C57BL/6 and BALB/c mice.** *Brain, Behavior, and Immunity* 7(4):326-333.
Descriptors: mouse, inbred, male, keyhole limpet hemocyanin, isolation, group-reared, IgM, IgG.

Klipple, J.A. (1978). **Behavioral persistence following switchovers between environmental enrichment and impoverishment in mice.** *Developmental Psychobiology* 11(6):541-557.
NAL call number: QP351 D4
Descriptors: mouse, weanling, environmental enrichment, impoverishment, behavior.

Koyama, S. (1993). **Isolation effect in mice (*Mus musculus*):(i) Does it really induce aggression?** *Journal of Ethology* 11(2):117-130.
NAL call number: QL750 J68
Descriptors: mouse, isolation, group-reared, dominance, territorial dominance, behavior.

Koyama, S. (1993). **Isolation effect in mice (*Mus musculus*):(ii) Variance in aggression.** *Journal of Ethology* 11(2):131-140.
NAL call number: QL750 J68
Descriptors: mouse, isolation, dominance, behavior.

Kropveld, D. and R.A. Chamuleau (1993). **Doppler radar device as a useful tool to quantify the liveliness of the experimental animal.** *Medical and Biological Engineering and Computing* 31(4):340-342.
Descriptors: mouse, BALB/c, rat, Wistar, activity, circadian rhythm.

Kubanis, P., S.F. Zornetzer, and G. Freund (1982). **Memory and postsynaptic cholinergic receptors in aging mice.** *Pharmacology, Biochemistry, and Behavior* 17(2):313-322.
NAL call number: QP901 P4
Descriptors: mouse, C57BL/6, male, female, young, old, passive avoidance tasks, ^{3}H-QNB, muscarinic receptor binding, benzodiazepine binding, cortex, striatum, hippocampus, cerebellum, brain stem.

Levine, L., J. Grossfield, and R.F. Rockwell (1979). **Functional relationships between genotypes and environments in behavior: Effects of different kinds of early social experience on interstrain fighting in male mice.** *Journal of Heredity* 70(5):317-320.
NAL call number: 442.8 Am3
Descriptors: mouse, ST/bJ, CBA/J, male, socially reared, isolation, behavior.

Manosevitz, M. and J.B. Pryor (1975). **Cage size as a factor in environmental enrichment.** *Journal of Comparative and Physiological Psychology* 89(6):648-654.
NAL call number: 410 J822
Descriptors: mouse, C57BL/6J, cage size, surface texture, wire, Plexiglas, body weight, open-field, defecation, running-wheel, exploration, water consumption.

Manosevitz, M., R.B. Campenot, and C.F. Swencionis (1968). **Effects of enriched environment upon hoarding.** *Journal of Comparative and Physiological Psychology* 66(2):319-324.
NAL call number: 410 J822
Descriptors: mouse, inbred, genotype, genotype/environment interactions.

Manosevitz, M. and U. Joel (1973). **Behavioral effects of environmental enrichment in randomly bred mice.** *Journal of Comparative and Physiological Psychology* 85(2):373-382.
NAL call number: 410 J822
Descriptors: mouse, open field, defecation, running wheel, exploration, hoarding, activity, adrenal gland, body weight, behavior.

Manosevitz, M. (1970). **Early environmental enrichment and mouse behavior.** *Journal of Comparative and Physiological Psychology* 71(3):459-466.
NAL call number: 410 J822
Descriptors: mouse, open field, running wheel, food competition, defecation.

Manosevitz, M. and R.J. Montemayor (1972). **Interaction of environmental enrichment and genotype.** *Journal of Comparative and Physiological Psychology* 79(1):67-76.
NAL call number: 410 J822
Descriptors: mouse, A/J, C3H/HeJ, C57BL/10J, neonate, weanling, open field, exploration, running wheel, activity.

Martinez, S., M. Ramirez, A. Salvador, and V.M. Simon (1993). **Olfaction of defeated mice may play an important role in subsequent agonistic behavior of the winners.** *Aggressive Behavior* 19(1):60-61.
NAL call number: BF575 A3A57
Descriptors: mouse, male, isolation, socially housed, behavior, exploration, activity, abstract.

McGregor, P.K., C. Barnard, and J.L. Hurst (1992). **Reply [to R.B. Jones on Varied cages and aggression].** *Applied Animal Behaviour Science* 33: 297-299.
NAL call number: QL750 A6
Descriptors: mouse, male, aggression, caging, objects, dominance, submission, fighting, animal welfare, environmental enrichment, anthropocentric view, olfaction.

McGregor, P.K. and S.J. Ayling (1990). **Varied cages result in more aggression in male CFLP mice.** *Applied Animal Behaviour Science* 26(3):277-281.
NAL call number: QL750 A6
Descriptors: mouse, CFLP, male, behavior, caging.

Misslin, R. and P. Ropartz (1981). **Responses of mice to a novel object.** *Behaviour* 78(3-4):169-177.
NAL call number: 410 B393
Descriptors: mouse, Swiss albino, male, novel environment, familiar environment, contacts, behavior.

Mondragon, R., L. Mayagoitia, A. Lopez-Lujan, and J.-L. Diaz (1987). **Social structure features in three inbred strains of mice, C57BL/6J, Balb/cj, and NIH: A comparative study.** *Behavioral and Neural Biology* 47(3):384-391.
NAL call number: QH301 C63
Descriptors: mouse, male, adult, inbred, behavior, aggression, exercise wheel.

Mulder, J.B. (1975). **Bedding preferences of pregnant laboratory reared mice.** *Behavior Research Methods and Instrumentation* 7(1):21-22.
Descriptors: mouse, female, bedding.

Nielsen, J., O. Andersen, and P. Svendsen (1985). **Induction of liver-enzymes in mice by alpha-pinene from softwood bedding.** *Zeitschrift für Versuchstierkunde* 27((2):105.
NAL call number: 410 Z36
Descriptors: mouse, bedding, spruce/pine shavings, pinene, P-450 enzymes, anesthesia.

Nielsen, J.B., Andersen, O., and P. Svendsen (1986). **Hepatic O-deethylase activity in mice on different types of bedding.** *Zeitschrift für Versuchstierkunde* 28(1-2):69-75.
NAL call number: 410 Z36
Descriptors: mouse, male, female, wood shavings.

Petitto, J.M., D.T. Lysle, J.L. Gariepy, and M.H. Lewis (1994). **Association of genetic differences in social behavior and cellular immune responsiveness: Effects of social experience.** *Brain, Behavior, and Immunity* 8(2):111-122.
Descriptors: mouse, ICR, social behavior, isolation-induced aggressiveness, group housing, tumor development, natural killer cells, T cells, B cells.

Port, C.D. and J.P. Kalenbach (1969). **The effect of corncob bedding on reproductivity and leucine incorporation in mice.** *Laboratory Animal Care* 19(1):46-49.
NAL call number: 410.9 P94
Descriptors: mouse, mycotoxins, dietary proteins, liver metabolism.

Schrott, L.M., V.H. Denenberg, G.F. Sherman, N.S. Waters, G.D. Rosen, and A.M. Galaburda (1992). **Environmental enrichment, neocortical ectopias, and behavior in the autoimmune NZB mouse.** *Developmental Brain Research* (Netherlands) 67(1):85-93.
Descriptors: mouse, New Zealand Black, male, discrimination learning, spatial maze, shuttlebox, autoimmune disease.

Smith, W. and S. Ross (1953). **The hoarding behavior of the mouse.** *The Journal of Genetic Psychology* 82: 279-316.
Descriptors: mouse, behavior, feed.

Tennekes, H.A., A.S. Wright, K.M. Dix, and J.H. Koeman (1981). **Effects of dieldrin, diet, and bedding on enzyme function and tumor incidence in livers of male CF-1 mice.** *Cancer Research* 41(9):3615-3620.
NAL call number: 448.8 C16
Descriptors: mouse, CF-1, male, bedding, Douglas fir sawdust, body weight, organ weight, hepatomas, hepatocellular enzymes.

Terranova, M.L., G. Laviola, and E. Alleva (1993). **Ontogeny of amicable social behavior in the mouse: gender differences and ongoing isolation outcomes.** *Developmental Psychobiology* 26(8):467-481.
NAL call number: QP351 D4
Descriptors: mouse, outbred CD-1, male, female, weanling, isolation, pair housing, play behavior, social interactions, exploration, activity, affiliative behavior.

Torronen, R., K. Pelkonen, and S. Karenlampi (1989). **Enzyme-inducing and cytotoxic effects of wood-based materials used as bedding for laboratory animals. Comparison by a cell culture study. [published erratum appears in Life Science 1989: 45(24):2381]** *Life Science* 45(6):559-565.
NAL call number: 442.8 L62
Descriptors: mouse hepatoma cell line, Hepa-1, hardwoods (aspen and alder), softwoods (pine and pine-spruce), cellulose materials, cytochrome P450I1A, aldehyde dehydrogenase.

van de Weerd, H. A., V. Baumans, J.M. Koolhaas, and L.F.M. van Zutphen (August 1994). **Strain specific behavioural response to environmental enrichment in the mouse.** *Journal of Experimental Animal Science*. 36(4-5):117-127.
Descriptors: behavior, environment design, housing, Inbred BALB C, Inbred C57BL, species specificity.

Vlahakis, G. (1977). **Possible carcinogenic effects of cedar shavings in bedding of C3H-AVY FB mice.** *Journal of the National Cancer Institute* 58(1):149-150.
NAL call number: 176.622 J82
Descriptors: mouse, C3H-AVY, female, bedding, pine shavings, cedar shavings, mammary gland tumors.

Wainwright, P.E., Y.S. Huang, B. Bulman-Fleming, S. Levesque, and D. McCutcheon (1994). **The effects of dietary fatty acid composition combined with environmental enrichment on brain and behavior in mice.** *Behavioural Brain Research* 60(2):125-136.
Descriptors: mouse, male, female, pregnancy, weaning, nutrition, brain composition, Morris water maze, learning.

Wainwright, P.E., S. Levesque, L. Krempulec, B. Bulman-Fleming, and D. McCutcheon (1993). **Effects of environmental enrichment on cortical depth and Morris-maze performance in B6D2F2 mice exposed prenatally to ethanol.** *Neurotoxicology and Teratology* 15(1):11-20.
Descriptors: mouse, cortex, body weight, water maze, learning.

Ward, G.E. and D. DeMille (1991). **Environmental enrichment for laboratory mice (*Mus musculus*).** *Animal Technology: Journal of the Institute of Animal Technology* 42(3):149-156.
NAL call number: QL55 I5
Descriptors: mouse, environmental enrichment, cages, bottles, toys.

Warren, J.M., C. Zerweck, and A. Anthony (1982). **Effects of environmental enrichment on old mice.** *Developmental Psychobiology* 15(1):13-18.
NAL call number: QP351 D4
Descriptors: mouse, C57BL/6J, male, old, behavior, brain chemistry, toys, housing, females, cerebral cortex, maze, tasks.

Wilson, R.A. and P.S. Coulson (1984). **The effect of soft-wood bedding on the maturation of an infection of *Schistosoma mansoni* in mice exposed to cercariae via the tail or abdominal skin.** *Transactions of the Royal Society of Tropical Medicine and Hygiene* 78(3):411-412.
NAL call number: 448.9 R813
Descriptors: mouse, bedding, softwood sawdust, *Schistosoma mansoni*.

Yates, G., J. Panksepp, S. Ikemoto, E. Nelson, and R. Conner (1991). **Social isolation effects on the "behavioral despair" forced swimming test: Effect of age and duration of testing.** *Physiology and Behavior* 49(2):347-353.
NAL call number: QP1 P4
Descriptors: mouse, Swiss Webster, male, female, weanling, young depression, immobility, body weight, reserpine.

Yoshimura, H. and N. Kimura (1993). **Ethopharmacology of behavioral disorders induced by prolonged individual housing in male mice.** *Japanese Journal of Pharmacology* 61(Supplement 1):94.
Descriptors: mouse, male, isolation, copulation, imipramine, chlordiazepoxide, anti-psychotic drugs.

Zahem, H.B. and C.W. Alliston (1974). **The effects of noise level and elevated ambient temperature upon selected reproductive traits in female Swiss Webster mice.** *Laboratory Animal Science* 24(3):469-475.
NAL call number: 410.9 P94
Descriptors: mouse, Swiss Webster, female, temperature, noise, reproduction, embryos, gestation.

RATS

Ando, S., Y. Ohashi, and S. Kobayashi (1993). **Enhancement of learning ability by enriched environment.** *Neuroscience Research Supplement* 0(18):S150.
Descriptors: rat, environmental enrichment, learning, abstract.

Anzaldo, A.J., P.C. Harrison, G.L. Riskowski, L.A. Sebek, R-G. Maghirang, W.R. Stricklin, and H.W. Gonyou (1994). **Increasing welfare of laboratory rats with the help of spatially enhanced cages.** *Animal Welfare Information Center Newsletter* 5(3):1-2, 5.
NAL call number: aHV4701 A952
Descriptors: rat, Sprague-Dawley, male, caging, platforms, decks, cage dividers, spatially enhanced.

Armario, A., J.M. Castellanos, and J. Balaseh (1985). **Chronic noise stress and insulin secretion in male rats.** *Physiology and Behavior* 34:359-361.
NAL call number: QP1 P4
Descriptors: rat, male, stress, insulin, noise, behavior.

Batchelor, G.R. (1994). **The rest/activity rhythm of the laboratory rat housed under different systems.** *Animal Technology: Journal of the Institute of Animal Technicians* 45(3):181-187.
NAL call number: QL55 I5
Descriptors: rat, Wistar, male, sleep, activity, caging, isolation, socially reared, ladders, climbing frame, funnel, tubes, boxes, nesting container, film canisters, foraging devices.

Batchelor, G.R. (1993). **An enriched commune housing system for laboratory rats: A preliminary view.** *Animal Technology: Journal of the Institute of Animal Technicians* 44(3):201-213.
NAL call number: QL55 I5
Descriptors: rat, rabbit, housing, social groups, behavior, ladders, shelves, tubes, funnels, climbing frame, boxes.

Bean, G. and T. Lee (1991). **Social isolation and cohabitation with haloperidol-treated partners: Effect on density of striatal dopamine D2 receptors in the developing rat brain.** *Psychiatry Research* 36(3):307-317.
Descriptors: rat, male, female, weanling, young, isolation, striatum, handling.

Bennett, E.L., et al. (1974). **Effects of successive environments on brain measures.** *Physiology and Behavior* 12(4):621-631.
NAL call number: QP1 P4
Descriptors: rat, Berkeley S_1, environmental enrichment, impoverished, cerebrum, brain weight, acetylcholinesterase, cholinesterase, interlaboratory comparison.

Bennett, E.L., M.R. Rosenzweig, and M.C. Diamond (1969). **Rat brain: Effects of environmental enrichment on wet and dry weights.** *Science* 163(3869):825-826.
NAL call number: 470 Sci2
Descriptors: rat, Berkeley S_1, male, cortex, brain weight, impoverished.

Bernstein, L. (1972). **The reversibility of learning deficits in early environmentally restricted rats as a function of amount of experience in later life.** *Journal of Psychosomatic Research* 16(1):71-73.
Descriptors: rat, environmental enrichment, isolation, learning.

Bernstein, L. (1973). **A study of some enriching variables in a free-environment for rats.** *Journal of Psychosomatic Research* 17(2):85-88.
Descriptors: rat, space, visual enrichment, toys, running wheel, activity, learning.

Bernstein, L. (1979). **Hebb's claim of irreversibility in environmentally restricted rats.** *American Psychologist* 34(9):802-803.
Descriptors: rat, learning, problem solving, environmental enrichment.

Bhide, P.G. and K.S. Bedi (1985). **The effects of a 30 day period of environmental diversity on well-fed and previously undernourished rats: Neuronal and synaptic measures in the visual cortex (area 17).** *Journal of Comparative Neurology* 236(1):121-126.
NAL call number: QP351 J68
Descriptors: rat, fetus, neonate, adult, nutrition, visual cortex, histology.

Birke, L.I. and D. Sadler (1988). **Effects of modulating neonatal progestins and androgens on the development of play and other social behavior in the rat.** *Hormones and Behavior* 22(2):160-171.
NAL call number: QP801 H7H64
Descriptors: rat, male, female, testosterone anti-serum, progestin anti-serum, medroxyprogesterone.

Black, J.E., M. Polinsky, and W.T. Greenough (1989). **Progressive failure of cerebral angiogenesis supporting neural plasticity in aging rats.** *Neurobiology of Aging* (USA) 10(4):353-358.
Descriptors: rat, old, capillaries, synaptogenesis, visual cortex, toys.

Bokovin, A.G. and E.S. Petrov (1992). **Influence of perceptual experience on the agonistic behavior of rats bred in isolation.** *Zhurnal Vysshei Nervnoi Deyatel'nosti* 42(4):800-802.
Descriptors: rat, male, neonate, adult, behavior, social interactions.

Borg, E. and A.R. Moller (1978). **Noise and blood pressure: Effect of lifelong exposure in the rat.** *Acta Physiologica Scandinavia* 103: 340-342.
NAL call number: QP1 A2
Descriptors: rat, Sprague-Dawley, Wistar, Lancing horns, long term study.

Bowling, S.L., J.K. Rowlett, and M.T. Bardo (1993). **The effect of environmental enrichment on amphetamine-stimulated locomotor activity, dopamine synthesis, and dopamine release.** *Neuropharmacology* 32(9):885-893.
NAL call number: RM315 N4
Descriptors: rat, male, environmental enrichment, impoverished, nucleus accumbens, striatum, *in vivo*, *in vitro*.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Brenner, E., M. Mirmiran, H.B.M. Uylings, and J. Van Der Gugten (1985). **Growth and plasticity of cerebral cortex after central noradrenaline depletion.** *Experimental Neurology* 89(1):264-268.
NAL call number: RC231 E96
Descriptors: rat, Wistar, bilateral ICV injection, 6-hydroxydopamine, brain growth.

Buelke-Sam, J., P.A. Sullivan, C.A. Kimmel, and C.J. Nelson (1984). **Sex and strain differences in the developmental activity profile of the rat tested over clean vs. home cage bedding.** *Developmental Psychobiology* 17(1):67-77.
NAL call number: QP351 D4
Descriptors: rat, CD, Long-Evans, male, female, neonate, olfaction, behavior, hyperactivity.

Burgess, M.L., J.M. Davis, T.K. Borg, S.P. Wilson, W.A. Burgess, and J. Buggy (1993). **Exercise training alters cardiovascular and hormonal responses to intracranial self-stimulation.** *Journal of Applied Physiology* 75(2):863-869.
NAL call number: 447.8 J825
Descriptors: rat, male, endocrine system, treadmill, ventral tegmental area, lever pressing, adrenal, organ weights, body weight.

Burkhart, C.A. and J.L. Robinson (1978). **High rat pup mortality attributed to use of cedar wood shavings as bedding.** *Laboratory Animals* 12(4):221-222.
NAL call number: QL55 A1L3
Descriptors: rat, Sprague-Dawley, male, female, adult, neonate, bedding, corncobs, aspen shavings, cedar shavings, mortality.

Camel, J.E., G.S. Withers, and W.T. Greenough (1986). **Persistence of visual cortex dendritic alterations induced by postweaning exposure to a "superenriched" environment in rats.** *Behavioral Neuroscience* 100(6):810-813.
NAL call number: QP351 B45
Descriptors: rat, postweaning, toys, maze, barriers, occipital cortex, neuronal development.

Carughi, A., K.J. Carpenter, and M.C. Diamond (1989). **Effect of environmental enrichment during nutritional rehabilitation on body growth, blood parameters, and cerebral cortical development of rats.** *Journal of Nutrition* (USA) 119(12):2005-2016.
NAL call number: 389.8 J82
Descriptors: rat, male, neonate, malnutrition, dendrites, occipital cortex, toys.

Caul, W.F., B.J. Freeman, and D.C. Buchanan (1975). **Effects of differential rearing condition on heart rate conditioning and response suppression.** *Developmental Psychobiology* 8(1):63-68.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, male, female, weanling, environmental enrichment, isolation.

Chaloupka, Z., J. Myslivecek, B. Semiginovsky, and J. Hassmannova (1971). **The effect of afferentation in early postnatal life on the formation of temporary connections and other properties of the brain.** *Activitas Nervosa Superior* 13(2):147-148.
Descriptors: rat, environmental enrichment, impoverished, neural activity.

Chao, H.M., D.C. Blanchard, R.J. Blanchard, B.S. McEwen, and R.R. Sakai (1993). **The effect of social stress on hippocampal gene expression.** *Molecular and Cellular Neurosciences* 4(6):543-548.
Descriptors: rat, male, female, visible burrows, dominance, interactions, behavior, neuroendocrine effects, corticosterone, glucocorticoid receptor, mineralocorticoid receptor, mRNA, growth-associated protein, preproenkephalin.

Chia-Hung, H., W. Ching-Hsien, J. Tz-Yi, and W.C. Su-Yu, (1976). **The effects of learning and environment on the rat's brain.** *Acta Psychologica Taiwanica* 18:25-30.
Descriptors: rat, cortex, environmental enrichment, learning, Hebb-Williams maze, methamphetamine, brain weight, acitivity.

Coburn, J.F. and R.D. Tarte (1976). **The effect of rearing environments on the contrafreeloading phenomenon in rats.** *Journal of the Experimental Analysis of Behavior* 26(2):289-294.
Descriptors: rat, Wistar, male, female, environmental enrichment, impoverishment, operant chambers, feed acquisition.

Cowie, S., S. Quintero, and N. McNaughton (1987). **Home cage and test apparatus artifacts in assessing behavioural effects of diazepam in rats.** *Psychopharmacology* 91(2):257-259.
Descriptors: rat, partial reinforcement, extinction effect, sodium amylobarbitone, chlordiazepoxide, anxiolytics.

Coyle, I.R. and G. Singer (1975). **The interactive effects of prenatal imipramine exposure and postnatal rearing conditions on behaviour and histology.** *Psychopharmacologia* 44(3):253-256.
Descriptors: rat, Wistar, male, female, weanling, imipramine, environmental enrichment, impoverished, brain histology, behavior.

Coyle, I.R. and G. Singer (1975). **The interaction of postweaning housing conditions and prenatal drug effects on behaviour.** *Psychopharmacologia* 41(3):237-244.
Descriptors: rat, Wistar, male, female, weanling, imipramine, Vitamin A, environmental enrichment, impoverished, Henderson-type maze, swimming maze.

Crepeau, L.J. (1990). **The interactive influences of early handling, prior play exposure, acute stress, and sex on play behavior, exploration, and H-P-A reactivity in juvenile rats.** *Dissertation Abstracts International* 51(3-B):1133.
NAL call number: Z5055.U49D53
Descriptors: rat, adrenal glands, hypothalamo-pituitary-adrenal axis.

Crnic, L. (1983). **Effects of nutrition and environment on brain biochemistry and behavior.** *Developmental Psychobiology* 16(2):129-145.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, female, malnutrition, environmental enrichment, behavior, open field, passive-avoidance performance.

Crnic, L.S. (1984). **Nutrition and mental development.** *American Journal of Mental Deficiency* 88(5):526-533.
Descriptors: rat, environmental enrichment, isolation, malnutrition, behavior, biochemical deficits.

Cummins, R.A., et al. (1973). **Environmentally-induced changes in the brains of elderly rats.** *Nature* 243(5409):516-518.
NAL call number: 472 N21
Descriptors: rat, Wistar, male, female, weanling, old, environmental enrichment, isolation, toys, maze, brain weight, behavior, plasticity.

Cummins, R.A., P.J. Livesey, and J.G. Evans (1977). **A developmental theory of environmental enrichment.** *Science* 197(4304):692-694.
NAL call number: 470 Sci2
Descriptors: rat, male, brain development, environmental enrichment, deprivation.

Dalrymple-Alford, J.C. and C.R. Kelche (1987). **Behavioral effects of differential postoperative housing after septal lesions made in weanling rats.** *Psychobiology* 15(3):255-260.
Descriptors: rat, male, weanling, behavior, open field, radial maze.

Dalrymple-Alford, J., C. Kelche, F. Eclancher, and B. Will (1988). **Preoperative enrichment and behavioral recovery in rats with septal lesions.** *Behavioral and Neural Biology* 49(3):361-373.
NAL call number: QH301 C63
Descriptors: rat, male, weaning, adult, behavior, open field, radial maze.

Davis, S.F. et al. (1975). **Contrafreeloading as a function of early environmental rearing conditions.** *Bulletin of the Psychonomic Society* 6(6):595-597.
Descriptors: rat, Holtzman, male, environmental enrichment, impoverished, feed acquisition, learning.

DeBlieux, P.M.C. (1993). **Exercise training improves cardiac performance in diabetic rats.** *Proceedings of the Society for Experimental Biology and Medicine* 203(2):209-213.
NAL call number: 442.9 S1
Descriptors: rat, female, cardiomyopathy, streptozotocin, diabetes mellitus, treadmill.

Dell, P.A. and F.D. Rose (1986). **The impairing effects of environmental impoverishment in rats: A cognitive deficit?** *IRCS Medical Science: Psychology and Psychiatry* 14(1-2):19-20.
Descriptors: rat, Hooded Lister, male, Hebb-Williams maze, learning activity, exploratory behavior.

Dell, P.A., and F.D. Rose (1987). **The role of environmentally induced brain changes in subserving behavioural function: An investigation in female rats postpartum.** *Medical Science Research* 15(16):959-960.
Descriptors: rat, female, virgin, pregnant, cortical depth, enrichment.

Dell, P.A. and F.D. Rose (1987). **Transfer of effects from environmentally enriched and impoverished female rats to future offspring.** *Physiology and Behavior* 39(2):187-190.
NAL call number: QP1 P4
Descriptors: rat, female, behavior, pre-pregnancy, pregnancy.

Deni, R., et al. (1982). **Effect of cross-litter pup and cage bedding changes on huddling in rat pups.** *Psychological Record* 32(4):543-549.
Descriptors: rat, Norway, male, female, neonate, contact behavior, ultrasonic vocalizations, olfaction.

Devenport, L., S. Dallas, C. Carpenter, and M.J. Renner (1992). **The relationship between adrenal steroids and enrichment-induced brain growth.** *Behavioral and Neural Biology* (USA) 58(1):45-50.
NAL call number: QH301 C63
Descriptors: rat, male, brain weight, adrenalectomy, corticosterone.

Diamond, M.C., R.E. Johnson, A.M. Protti, et al. (1985). **Plasticity in the 904-day-old male rat cerebral cortex.** *Experimental Neurology* 87(2):307-317.
NAL call number: RC321 E96
Descriptors: rat, Long-Evans, male, toys, frontal cortex, parietal cortex, occipital cortex, histology.

Diamond, M.C., et al. (1977). **Effects of aging and environment on the pyriform cortex, the occipital cortex and the hippocampus.** *Behavioral and Neural Biology* 20(3):325-336.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, male, neonates, old, brain thickness, brain development, memory.

Diamond, M.C., E.R. Greer, A. York, et al. (1987). **Rat cortical morphology following crowded-enriched conditions.** *Experimental Neurology* 96(2):241-247.
NAL call number: RC321 E96
Descriptors: rat, male, medial occipital cortex, toys, caging.

Domjan, M., R. Schorr, and M. Best (1977). **Early environmental influences on conditioned and unconditioned ingestional and locomotor activity.** *Developmental Psychobiology* 10(6):499-506.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, post-weaning, socialization, isolation, handling, aversive stimuli, taste aversion, open field, gustatory-visceral sensory system, telereceptor-cutaneous sensory system.

Doty, B.A. (1972). **The effects of cage environment upon avoidance responding of aged rats.** *Journal of Gerontology* 27(3):358-360.
NAL call number: 447.8 J824
Descriptors: rat, Sprague-Dawley, old, environmental enrichment, impoverished, learning.

Ducommun, D. (1993). **Humane care of laboratory rats.** *AWI Quarterly (Animal Welfare Institute)* 42(4):14.
NAL call number: HV4761 A5
Descriptors: rat, social groups, behavior, caging, handling, identification, exercise, gnawing, running wheel, toys, nest building, psychology experiments.

Dunnett, S.B., I.Q. Whishaw, S.T. Burch, and A. Fine (1986). **Acetylcholine-rich neuronal grafts in the forebrain of rats: Effects of environmental enrichment, neonatal noradrenaline depletion, host transplantation site and regional source of embryonic donor cells on graft size and acetylcholinesterase-positive fibre outgrowth.** *Brain Research* 378(2):357-373.
NAL call number: Film S-1779
Descriptors: rat, Sprague-Dawley, male, neocortex, nucleus basalis lesions, hippocampus, fimbria-fornix lesions.

Dwoskin, L.P., A.L. Jewell, S.T. Buxton, M. Bradley, and M.T. Bardo (1993). **Environmental enrichment decreases the sensitivity of dopamine autoreceptors in rat nucleus accumbens.** *Society for Neuroscience Abstracts* 19(1-3):822.
NAL call number: QP351 S6
Descriptors: rat, environmental enrichment, amphetamine, striatum.

Edward, H.P., W.F. Barry, and J.O. Wyspianski (1968). **Early environment effects on rat photic evoked potentials: A preliminary study.** *Revista Interamericana de Psicologia* 2(2):85-92.
Descriptors: rat, Sprague-Dawley, male, environmental enrichment, cortical potentials.

Einon, D. and M. Potegal (1991). **Enhanced defense in adult rats deprived of playfighting experience as juveniles.** *Aggressive Behavior* 17(1):27-40.
NAL call number: BF575 A3A57
Descriptors: rat, male, isolation, pairs, defense, tonic immobility, social threat.

Einon, D.F., M.J. Morgan, and B.E. Will (1980). **Effects of post-operative environment on recovery from dorsal hippocampal lesions in young rats: Tests of spatial memory and motor transfer.** *Quarterly Journal of Experimental Psychology* 32(1):137-148.
Descriptors: rat, Long-Evans, male, young, hippocampal lesions, learning, memory tasks, motor tasks.

Escorihuela, R.M., A. Tobena, and A. Fernandez-Teruel (1994). **Environmental enrichment reverses the detrimental action of early inconsistent stimulation and increases the beneficial effects of postnatal handling on shuttlebox learning in adult rats.** *Behavioural Brain Research* 61(2):169-173.
Descriptors: rat, Sprague-Dawley, neonate, adult, postnatal handling, active avoidance task, learning.

Faith, R.E., S.J. Henning, D.R. McCarty and W.F. McKenzie (1985). **Reduction of reproductive efficiency in Sprague-Dawley rats by softwood bedding.** *Laboratory Animal Science* 35(5):555.
NAL call number: 410.9 P94
Descriptors: rat, Sprague-Dawley, abstract.

Falkenberg, T., A.K. Mohamed, B. Henriksson, H. Persson, B. Winblad, and N. Lindefors (1992). **Increased expression of brain-derived neurotrophic factor mRNA in rat hippocampus is associated with improved spatial memory and enriched environment.** *Neuroscience Letters* (Ireland) 138(1):153-156.
NAL call number: QP351 N3
Descriptors: rat, water maze, learning, memory, brain-derived neurotrophic factor.

Ferchmin, P.A., V.A. Eterovic, and L.E. Levin (1980). **Genetic learning deficiency does not hinder environment-dependent brain growth.** *Physiology and Behavior* 24(1):45-50.
NAL call number: QP1 P4
Descriptors: rat, shuttlebox avoidance, exploratory behavior, Greek Cross apparatus, brain weight.

Ferchmin, P.A., E.L. Bennett, and M.R. Rosenzweig (1975). **Direct contact with enriched environment is required to alter cerebral weight in rats.** *Journal of Comparative and Physiological Psychology* 88(1):360-367.
NAL call number: 410 J822
Descriptors: rat, Berkeley S_1, interaction with environment, environmental enrichment, isolation, impoverished, brain weight, behavior.

Ferchmin, P.A. and V.A. Eterovic (1990). **Experience affects cortical but not subcortical polyamines.** *Pharmacology, Biochemistry, and Behavior* (USA) 35(1):255-258.
NAL call number: QP901 P4
Descriptors: rat, occipital cortex, cortex, subcortex, cerebellum, DFMO, spermidine, spermine, putrescine.

Fernandez, V., R. Pascual, and S. Ruiz (1993). **Early-life environmental deterioration, nutrition, and ontogeny of the motor cortex in the rat - A Golgi study.** *Biology of the Neonate* 64(4):245-253.
NAL call number: QH301 B46
Descriptors: rat, Sprague-Dawley, impoverished housing, diet, cortex, neurons, body weight, size, motor pyramids, dendrites.

Fessler, R.G. and W.W. Beatty (1976). **Variations in postweaning environment and sensitivity to electric shock in male and female rats.** *Behavioral Biology* 16(4):535-538.
NAL call number: QH301 C63
Descriptors: rat, Holtzman-derived, male, female, environmental enrichment, isolation, shock thresholds, open field, behavior.

Fiala, B., F.M. Snow, and W.T. Greenough (1977). **"Impoverished" rats weigh more than "enriched" rats because they eat more.** *Developmental Psychobiology* 10(6):537-541.
NAL call number: QP351 D4
Descriptors: rat, Long-Evans, male, female, weanling, toys, isolation, socialization, boredom, body weight, feed consumption, water consumption.

Fordyce, D.J. and J.F. Knutson (1980). **Influence of blinding and home-cage lighting on aggressive behaviors of laboratory rats.** *Physiology and Behavior* 25:217-226.
NAL call number: QP1 P4
Descriptors: rat, hooded, male, blinding, home-cage aggression, shock-induced aggression, lighting.

Fowler, S.C., J.S. Johnson, M.J. Kallman, Jr. Liou, et al. (1993). **In a drug discrimination procedure isolation-reared rats generalize to lower doses of cocaine and amphetamine than rats reared in an enriched environment.** *Psychopharmacology* 110(1-2):115-118.
Descriptors: rat, male, environmental enrichment, isolation, operant procedure, dopaminergic agonists, learning.

Galef, B.J. Jr. and P. Durlach (1993). **Should large rats be housed in large cages? An empirical issue.** *Canadian Psychology* 34(2):203-207.
Descriptors: rat, preference test, cage size, behavior, Canadian Council on Animal Care.

Garcia-Brull, P.D., J. Nunez, and A. Nunez (1993). **The effect of scents on the territorial and aggressive behaviour of laboratory rats.** *Behavioural Processes* 29(1-2):25-36.
NAL call number: QL750 B4
Descriptors: rat, Wistar, male, female, young, adult, odors, dominance, behavior, urine, alpha male.

Gardner, E.B. et al. (1975). **Environmental enrichment and deprivation: Effects on learning, memory, and exploration.** *Physiology and Behavior* 14(3):321-327.
NAL call number: QP1 P4
Descriptors: rat, Long-Evans, perceptually enriched, socially enriched, impoverished, open field, learning, avoidance training, electric shock.

Geber, W.T., J.A. Anderson, and B. Van Dyne (1966). **Physiologic responses of the albino rat to chronic noise stress.** *Archives of Environmental Health* 12:751-754.
NAL call number: RC963 A1A7
Descriptors: rat, Sprague-Dawley, adrenal ascorbic acid, auditory stress, brain, eosinophils.

Gentile, A.M., Z. Beheshti, and J.M. Held (1987). **Enrichment versus exercise effects on motor impairments following cortical removals in rats.** *Behavioral and Neural Biology* 47(3):321-332.
NAL call number: QH301 C63
Descriptors: rat, male, CD, sensorimotor cortex, exercise wheel, environmental enrichment.

Gentsch, C., M. Lichtsteiner, and H. Feer (1981). **Taste neophobia in individually and socially reared male rats.** *Physiology and Behavior* 27(2):199-202.
NAL call number: QP1 P4
Descriptors: rat, male, isolation, socially reared, hyperactivity, fear, taste neophobia.

Gentsch, C., M. Lichtsteiner, K. Kraeuchi, and H. Feer (1982). **Different reaction patterns in individually and socially reared rats during exposure to novel environments.** *Behavioural Brain Research* 4:45-54.
Descriptors: rat, isolation, socially reared, behavior, housing.

Gogia, P.P., M. Brown, and S. Al-Obaidi (1993). **Hydrocortisone and exercise effects on articular cartilage in rats.** *Archives of Physical Medicine and Rehabilitation* 74(5):463-467.
Descriptors: rat, Sprague-Dawley, female, treadmill, knees, femoral cartilage, degeneration, fibrosis.

Goldman, H., R.F. Berman, S. Gershon, S.L. Murphy, et al. (1987). **Correlation of behavioral and cerebrovascular functions in the aging rat.** *Neurobiology of Aging* 8(5):409-416.
Descriptors: rat, cerebral blood flow, T-maze, environmental enrichment.

Gonzalez, B. B. Castellano, J.M. Vela, P. Fabregas, I. Dalmau, R.M. Escoriheula, A. Tobena, and A. Fernandez-Teruel (1994). **Infantile stimulation may protect against age-related deficits in RHA-Verh and RLA-Verh rats: A behavioral and histological study.** *Behavior Genetics* 24 (6):514-515(abstract).
Descriptors: brain, postnatal handling, environmental enrichment, learning, cognition.

Greenough, W.T., T.C. Madden, and T.B. Fleischmann (1972). **Effects of isolation, daily handling, and enriched rearing on maze learning.** *Psychonomic Science* 27(5):279-280.
Descriptors: rat, Long-Evans, male, activity, Lashley III maze, straight alley.

Greer, E.R., M.C. Diamond, and J.M. Tang (1982). **Environmental enrichment in Brattleboro rats: Brain morphology.** *Annals of the New York Academy of Sciences* 394:749-752.
NAL call number: 500 N484
Descriptors: rat, Brattleboro, male, heterozygous, homozygous, diabetes insipidus, neocortex, telencephalon, diencephalon, hippocampus, brain size, age.

Greer, E.R. (1982). **Environmental enrichment in rats with a memory deficit (Brattleboro strain).** *Dissertation Abstracts International* 42(7-B):2646-2647.
NAL call number: Film S-1805
Descriptors: rat, Brattleboro, brain morphology.

Gruendel, A.D. (1972). **The influence of experimental factors on the early development and sexual behavior of male rats.** *Dissertation Abstracts International* 33(4-B):1817-1818.
NAL call number: Z5055.U49D53
Descriptors: rat, male, female, environmental enrichment, isolation, impoverished, foster mothers, play.

Gulve, E.A., K.J. Rodnick, E.J. Henriksen, and J.O. Holloszy (1993). **Effects of wheel running on glucose transporter (GLUT4) concentration in skeletal muscle of young adult and old rats.** *Mechanisms of Ageing and Development* 67(1-2):187-200.
NAL call number: QP84 M4
Descriptors: rat, Long-Evans, female, young, old, running wheels, aging, citrate synthase, hexokinase, heart, epitrochlearis, flexor digitorum brevis.

Hagemeyer, J.A. and J. Panksepp (1988). **An attempt to evaluate the role of hearing in the social play of juvenile rats.** *Bulletin of the Psychonomic Society* 26(5):455-458.
Descriptors: rat, young, deafness, aminooxyacetic acid, kanamycin, acoustic startle.

Hamilton, W.L., M.C. Diamond, R.E. Johnson, and C.A. Ingham (1977). **Effects of pregnancy and differential environments on rat cerebral cortical depth.** *Behavioral and Neural Biology* 19(3):333-340.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, female, pregnant, nonpregnant, brain thickness, environmental enrichment, sex, hormonal state.

Hannigan, J.H., R.F. Berman, and C.S. Zajac (1993). **Environmental enrichment and the behavioral effects of prenatal exposure to alcohol in rats.** *Neurotoxicology and Teratology* 15(4):261-266.
Descriptors: rat, postweaning, isolation, groups, ataxia, Morris maze, postnatal environmental enrichment.

Harro, J. (1993). **Measurement of exploratory behavior in rodents.** In: *Methods in Neurosciences, Vol.14. Paradigms for the study of behavior* P.M. Conn, ed., Academic Press, Inc.: San Diego, CA, pp. 359-377.
NAL call number: QP351 M47
Descriptors: rat, male, female, housing, hormones, exploration.

Hart, L.A. (1994). **Opportunities for environmental enrichment in the laboratory.** *Lab Animal* 23(2):24-27.
NAL call number: QL55 A1L33
Descriptors: rats, rabbits, reptiles, zoo animals, farm animals, noise, housing, caging, burrows, nesting materials, social groups.

Held, J.M., J. Gordon, and A.M. Gentile (1985). **Environmental influences on locomotor recovery following cortical lesions in rats.** *Behavioral Neuroscience* 99(4):678-690.
NAL call number: QP351 B45
Descriptors: rat, sensorimotor cortex, locomotor tasks.

Hill, S.Y. and B.J. Powell (1976). **Cocaine and morphine self-administration: Effects of differential rearing.** *Pharmacology, Biochemistry, and Behavior* 5(6):701-704.
NAL call number: QP901 P4
Descriptors: rat, Wistar, post-weaning, environmental enrichment, impoverishment, choice test, morphine, cocaine, emotionality, conditionability, body weight.

Hole, G. (1991). **Proximity measures of social play in the laboratory rat.** *Developmental Psychobiology* 24(2):117-133.
NAL call number: QP351 D4
Descriptors: rat, male, female, littermates, spatial relationships, access to resources, territorial, cover.

Hole, G. (1991). **The effects of social deprivation on levels of social play in the laboratory rat--*Rattus norvegicus*.** *Behavioural Processes* 25(1):41-53.
NAL call number: QL750 B4
Descriptors: rat, male, weanling, isolation, social contact, rough-and-tumble play.

Hole, G. (1988). **Temporal features of social play in the laboratory rat.** *Ethology (formerly Zeitschrift für Tierpsychologie)* 78(1):1-20.
NAL call number: QL750 E74
Descriptors: rat, male, female, young, rough-and-tumble play, duration.

Holson, R.R. (1986). **Feeding Neophobia: A possible explanation for the differential maze performance of rats reared in enriched or isolated environments.** *Physiology and Behavior* 38(2):191-201.
NAL call number: QP1 P4
Descriptors: rat, Long-Evans, male, open field, emergence test, maze, handling.

Holson, R.R., A.C. Scallet, S.F. Ali, and B.B. Turner (1991). **"Isolation stress" revisited: Isolation-rearing effects depend on animal care methods.** *Physiology and Behavior* 49(6):1107-1118.
NAL call number: QP1 P4
Descriptors: rat, male, female, caging, handling, behavior, adrenocortical system, olfaction, open field.

Huck, U.W. and E.O. Price (1975). **Differential effects of environmental enrichment on the open field behavior of wild and domestic Norway rats.** *Journal of Comparative and Physiological Psychology* 89(8):892-898.
NAL call number: 410 J822
Descriptors: rat, Norway, wild, domestic, environmental enrichment, open field, behavior, body, weight, genetic influences.

Ikemoto, S. and J. Panksepp (1992). **The effects of early social isolation on the motivation for social play in juvenile rats.** *Developmental Psychobiology* 25(4):261-274.
NAL call number: QP351 D4
Descriptors: rat, weanling, family reared, peer, isolation, play, t-maze, rewards.

Ina, Y., K. Machida, K. Suzuki, and K. Tsukamoto (1994). **Effects of voluntary wheel running on health indexes in rats with SRBC-induced inflammation.** *Nippon Eiseigaku Zasshi (Japan)* 48(6):1077-1089.
Descriptors: rat, Fischer, male, sheep red blood cells, inflammation, voluntary exercise, feed intake, activity, body weight, blood chemistry, liver function.

Ivinskis, A. and J. Homewood (1980). **Effect of preweaning environmental enrichment on later problem-solving behavior in rats.** *Animal Learning and Behavior* 8(2):336-340.
NAL call number: QL785 A725
Descriptors: rat, female, neonates, handling, Hebb-Williams maze, vision.

Johansson, B.B. and A.-L. Ohlsson (1994). **An enriched environment enhances functional outcome in focal brain ischemia in the rat.** *Stroke* 25(1):265 (abstract).
Descriptors: rat, plasticity, cerebral artery.

Jones, D.G. and B.J. Smith (1980). **Morphological analysis of the hippocampus following differential rearing in environments of varying social and physical complexity.** *Behavioral and Neural Biology* 30(2):135-147.
NAL call number: QH301 C63
Descriptors: rat, Wistar, hippocampus, cortex, cell physiology, preweaning, postweaning, toys, multifamily groups, isolation.

Jones, G.H., C.A. Marsden, and T.W. Robbins (1991). **Behavioural rigidity and rule-learning deficits following isolation-rearing in the rat: neurochemical correlates.** *Behavioural Brain Research* 43(1):35-50.
Descriptors: rat, female, isolation, socialization, visual discrimination, learning, appetitive behavior, cerebral cortex, dopamine.

Joseph, R. and R.E. Gallagher (1980). **Gender and early environmental influences on activity, overresponsiveness, and exploration.** *Developmental Psychobiology* 13(5):527-544.
NAL call number: QP351 D4
Descriptors: rat, male, female, adult, environmental enrichment, running wheel, open field, maze, noxious stimuli.

Julin, C.M. and D.P. Thomas (1993). **Effects of age and exercise training on size and composition of the rat left main coronary artery.** *Journal of Gerontology* 48(3):B101-B107.
NAL call number: 447.8 J824
Descriptors: rat, Fischer 344, female, young, old, sedentary, treadmill, body weight, wall thickness, collagen, elastin.

Katz, H.B. and C.A. Davies (1982). **The effects of early under-nutrition and subsequent environment on morphological parameters of the rat brain.** *Behavioural Brain Research* 5(1):53-64.
Descriptors: rat, hooded Lister, male, undernourishment, brain growth spurt, forebrain, cortex, hippocampus, brain development.

Kazmaier, K., R.E. Butler, R.J. Senter, and R.M. Stutz (1973). **Rearing conditions and ethanol consumption by rats.** *Quarterly Journal of Studies on Alcohol* 34(2):520-524.
Descriptors: rat, Sprague-Dawley, male, emotionality, environmental enrichment, impoverished, handling, bedding, open field, activity.

Kelche, C., J.C. Dalrymple-Alford, and B. Will (1988). **Housing conditions modulate the effects of intracerebral grafts in rats with brain lesions.** *Behavioural Brain Research* 28(3):287-295.
Descriptors: rat, female, behavior, memory, fimbria-fornix, fetal grafts, Hebbs-Williams maze, acetylcholinesterase.

Kelche, C., J.C. Dalrymple-Alford, and B. Will (1987). **Effects of postoperative environment on recovery of function after fimbria-fornix transection in the rat.** *Physiology and Behavior* 40(6):731-736.
NAL call number: QP1 P4
Descriptors: rat, female, housing conditions, memory, radial maze.

Kelche, C. and B. Will (1982). **Effects of post-operative environments following dorsal hippocampal lesions on dendritic branching and spines in rat occipital cortex.** *Brain Research* 245(1):107-115.
NAL call number: Film S-1779
Descriptors: rat, Long-Evans, male, bilateral hippocampal lesions, pyramidal cells, morphology, behavior.

Kelche, C. and B.E. Will (1978). **Effects of environment on functional recovery after hippocampal lesions in adult rats.** *Physiology and Behavior* 21(6):935-941.
NAL call number: QP1 P4
Descriptors: rat, August, male, learning, bilateral lesions, hippocampus, Hebb-Williams maze.

Kemble, E.D. and V.A. Davies (1981). **Effects of prior environmental enrichment and amygdaloid lesions on consummatory behavior, activity, predation, and shuttlebox avoidance in male and female rats.** *Physiological Psychology* 9(4):340-346.
Descriptors: rat, Holtzman, male, female, water consumption, food consumption, activity levels, open field, avoidance test, sex differences.

Kirby, R.J. (1970). **Early environmental experience and avoidance learning in the rat.** *Psychonomic Science* 19(1):30-31.
Descriptors: rat, Sprague-Dawley, weanling, environmental enrichment, impoverished, passive-avoidance problem, emotions.

Kirby, R.J. and J.E. Kirby (1968). **Note: Early environmental experience and spontaneous alternation.** *Psychological Reports* 23(3, Pt.2):1278.
Descriptors: rat, environmental enrichment, impoverished, exploration, learning.

Kiyono, S., M.L. Seo, M. Shibagaki, and M. Inouye (1985). **Facilitative effects of maternal environmental enrichment on maze learning in rat offspring.** *Physiology and Behavior* 34(3):431-435.
NAL call number: QP1 P4
Descriptors: rat, female, pregnant, foster mothers, male offspring, Hebb-Williams maze, postnatal learning.

Klein, S.L., K.G. Lambert, D. Durr, T. Schaefer, and R.E. Waring (1994). **Influence of environmental enrichment and sex on predator stress response in rats.** *Physiology and Behavior* 56(2):291-297.
NAL call number: QP1 P4
Descriptors: rat, male, female, cat avoidance apparatus, stress, stomach, adrenal glands, thymus, defensive behavior.

Klinger, H.J. and E.D. Kemble (1985). **Effects of housing space and litter size on play behavior in rats.** *Bulletin of the Psychonomic Society* 23(1):75-77.
Descriptors: rat, Holtzman, male, female, neonate, caging, play, stress.

Klir, P., R. Bondy, J. Lachout, and T. Hanis (1984). **Physiological changes in laboratory rats caused by different housing.** *Physiologia Bohemoslavaca* 33:111-121.
Descriptors: rat, caging, physiology.

Kramer, K., H. Dijkstra, and A. Bast (1993). **Control of physical exercise of rats in a swimming basin.** *Physiology and Behavior* 53(2):271-276.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, swimming, exercise, superoxide dismutase, glutathione, diethyl maleate, emotions, maze, norepinephrine, epinephrine, lactate, stress.

Kuenzle, C.C. and A. Knusel (1974). **Mass training of rats in superenriched environment.** *Physiology and Behavior* 13(2):205-210.
NAL call number: QP1 P4
Descriptors: rat, male, apparatus, learning, maze, feed acquisition, water acquisition, behavior.

Larue-Achagiotis, C., C. Martin, P. Verger, M. Chabert, and J. Louis-Sylvestre (1993). **Effects of acute treadmill exercise and delayed access to food on food selection in rats.** *Physiology and Behavior* 53(2):403-408.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, total energy intake, nutrient self-selection, body weight, carbohydrates, protein, fat.

Latane, B. and D.C. Glass (1969). **Social and nonsocial attraction in rats.** *Journal of Personality and Social Psychology* 9(2, Pt. 1):142-146.
Descriptors: rat, Carworth, fear, open field, defecation, anesthetized rat, toy car, pair interaction, gregariousness.

Leah, J., H. Allardyce, and R. Cummins (1985). **Evoked cortical potential correlates of rearing environment in rats.** *Biological Psychology* 20(1):21-29.
NAL call number: QP351 B52
Descriptors: rat, Wistar, male, enriched environment, isolation.

LeFevre, J. and M.K. McClintock (1991). **Isolation accelerates reproductive senescence and alters its predictors in female rats.** *Hormones and Behavior* 25(2):258-272.
Descriptors: rat, Sprague-Dawley, female, aging, constant estrus, isolation, group rearing, lordosis reflex, ovarian steroids.

Liljequist, R., B.G. Henriksson, N. Latif, T. Pham, B. Winblad, and A.H. Mohammed (1993). **Subchronic MK-801 treatment to juvenile rats attenuates environmental enrichment effects on adult spatial learning.** *Behavioural Brain Research* 56(1):107-114.
Descriptors: rat, environmental enrichment, impoverished, NMDA receptor, open field, [^{3}H]MK-801 binding sites, cortex, learning, activity, cognitive changes.

Lore, R.K. (1969). **Pain avoidance behavior of rats reared in restricted and enriched environments.** *Developmental Psychology* 1(5):482-484.
NAL call number: BF712 D46
Descriptors: rat, Long-Evans, environmental enrichment, impoverished, candle, nose-flame contacts, emotions, perceptual deficits.

Louie, D.S. (1983). **The effects of an enriched environment on the consequences of lactational undernutrition on learning and on brain chemistry in rats.** *Dissertation Abstracts International* 44(1-B):117-118.
NAL call number: Z5055.U49D5
Descriptors: rat, undernutrition, learning, biochemistry.

Luciano, D. and R. Lore (1975). **Aggression and social experience in domesticated rats.** *Journal of Comparative and Physiological Psychology* 88(2):917-923.
NAL call number: 410 J822
Descriptors: rat, male, female, isolation socially reared, aggression, behavior, body weight, stress.

Mailloux, J.G., et al. (1974). **Effects of differential rearing on cortical evoked potentials of the albino rat.** *Journal of Comparative and Physiological Psychology* 87(3):475-480.
NAL call number: 410 J822
Descriptors: rat, Sprague-Dawley, weanling, visual enrichment, auditory enrichment, electrodes.

Matysiak, J. and Z. Toeplitz (1990). **Influence of genetic and environmental factors on self-exposure to sensory stimuli in rats.** *Ricerche di Psicolgia* 14(2):19-28.
Descriptors: rat, Wistar, Brown-Norway, male, environmental enrichment, behavioral tests.

Mazurski, E.J. (1994). **Handling and emotionality in laboratory rats.** In: *Improving the Well-being of Animals in the Research Environment: Proceedings of the conference held at the Marriott Hotel, Sydney, October, 1993* R.M. Baker, G. Jenkin, and D.J. Mellor, eds., Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART):Glen Osmond, SA, Australia, pp. 81-85.
NAL call number: in process
Descriptors: rat, handling, behavior, learning, aggressiveness, stress, fear, physiological responses.

McKee, J., P. Harrison, H. Gonyou, G. Riskowski, L. Sebek, and R. Maghirang (1993). **Effect of double density housing of laboratory rats in simulated space shuttle transport caging.** *FASEB Journal* 7(3-4):A620.
NAL call number: QH301 F3
Descriptors: rat, housing, cardiovascular system, abstract.

Menzaghi, F., S.C. Heinrichs, E. Merlo-Pich, F.J. Tilders, and G.F. Koob (1994). **Involvement of hypothalamic corticotropin-releasing factor neurons in behavioral responses to novelty in rats.** *Neuroscience Letters* 168(1-2):139-142.
NAL call number: QP351 N3
Descriptors: rat, paraventricular nucleus, locomotor activity, novel environments, housing, ricin A toxin, stress.

Mills, D.E., Y.S. Huang, M. Narce, and J.P. Poisson (1994). **Psychosocial stress, catecholamines, and essential fatty acid metabolism in rats.** *Proceedings of the Society for Experimental Biology and Medicine* 205(1):56-61.
NAL call number: 442.9 So1
Descriptors: rat, Wistar-Kyoto, normotensive, spontaneously hypertensive, Sprague-Dawley, epinephrine, isolation, group-reared, fatty acid desaturase.

Mirmiran, M., and H.B. Uylings (1983). **The environmental enrichment effect upon cortical growth is neutralized by concomitant pharmacological suppression of active sleep in female rats.** *Brain Research* 261(2):331-334.
Descriptors: rat, female, REM sleep, clonidine, brain weight, cortex.

Mitani, K. (1975). **Enhancement of general activity in the white rat through rearing in enriched environment.** *Annual of Animal Psychology* 24(2):73-85.
Descriptors: rat, male, environmental enrichment, cage size, toys, open field, activity, body weight, urination, defecation.

Mohamed, A.K., B. Winblad, T. Ebendal, and T. Larkfors (1990). **Environmental influence on behaviour and nerve growth factor in the brain.** *Brain Research* (Netherlands) 528(1):62-72.
NAL call number: Film S-1779
Descriptors: rat, Morris maze, nerve growth factor, septohippocampal pathway, Alzheimer's disease, environmental stimulation.

Mohammed, A.H., B.G. Henriksson, S. Soderstrom, T. Ebendal, T. Olsson, and J.R. Seckl (1993). **Environmental influences on the central nervous system and their implications for the aging rat.** *Behavioural Brain Research* 57(2):183-191.
Descriptors: rat, adult, old, neuronal plasticity, environmental enrichment, handling, glucocorticoid receptors, hippocampus, nerve growth factor.

Moore, C.L. and K.L. Power (1992). **Variation in maternal care and individual differences in play, exploration, and grooming of juvenile Norway rat offspring.** *Developmental Psychobiology* 25(3):165-182.
NAL call number: QP351 D4
Descriptors: rat, Norway, female, neonate, mothers, maternal anogenital licking, licking, time in nest, nursing, zinc sulfate, dietary saline.

Morgensen, J. (1991). **Influences of the rearing conditions on functional properties of the rat's prefrontal system.** *Behavioural Brain Research* (Netherlands) 42(2):135-142.
Descriptors: rat, male, visual pattern discrimination, maze, spatial delayed alternation, cortex.

Morinah, A. and B.E. Leonard (1980). **Some anatomical and physiological correlates of social isolation in the young rat.** *Physiology and Behavior* 24:637-640.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, weanling, isolation, socially reared, ascorbic acid, corticosterone, cortex, stress.

Morseth, S.L., H.A. Dengerink, and J.W. Wright (1985). **Effect of impulse noise on water consumption and blood pressure in the female rat.** *Physiology and Behavior* 34:1013-1016.
NAL call number: QP1 P4
Descriptors: rat, Sprague-Dawley, female, adult, impulse noise, drinking, blood pressure.

Muir, J.L., P.H. Pfister, and A. Ivinskis (1985). **Effects of prepartum stress and postpartum enrichment on mother-infant interaction and offspring problem-solving ability in *Rattus norvegicus*.** *Journal of Comparative Psychology* 99(4):468-478.
NAL call number: BF671 J6
Descriptors: rat, Wistar, female, behavior, Hebb-Williams maze, closed field.

Mulligan, B.E., S.C. Baker, and M.R. Murphy (1994). **Vocalizations as indicators of emotional state and psychological wellbeing in animals.** *Animal Welfare Information Center Newsletter* 5(3):3-4.
NAL call number: aHV4701 A952
Descriptors: rats, macaques, vocalizations, emotionality.

Murtha, S., B.A. Pappas, and S. Raman (1990). **Neonatal and adult forebrain norepinepherine depletion and the behavioral and cortical thickening effects of enriched/impoverished environment.** *Behavioural Brain Research* (Netherlands) 39(3):249-261.
Descriptors: rat, neonate, adult, Hebb-Williams maze, 6-OHDA, buproprion, depletion, learning.

Nayfield, K.C. and E.L. Beach (1981). **Comparative responses of rabbits and rats to elevated noise.** *Laboratory Animal Science* 31(4):386-390.
NAL call number: 410.9 P94
Descriptors: rat, rabbit, male, noise, adrenal gland, spleen, hematology, feed consumption, body weight, organ weight.

Nilsson, L., A.K.H. Mohammed, B.G. Henriksson, R. Folkesson, and B. Winblad (1993). **Environmental influence on somatostatin levels and gene expression in the rat brain.** *Brain Research* 628(1-2):93-98.
NAL call number: Film S-1779
Descriptors: rat, preprosomatostatin-mRNA, impoverished, environmental enrichment, spatial learning, open field, locomotor activity, cortex, hypothalamus.

Nott, H.M.R. and R.M. Sibly (1993). **Response to novel food by rats: Effects of social rank.** *Crop Protection* 12(2):89-94.
NAL call number: SB599 C8
Descriptors: rat, dominant, subdominant, neophobia, feeding.

Oehler, J., M. Jahkel, and J. Schmidt (1987). **Neuronal transmitter sensitivity after social isolation in rats.** *Physiology and Behavior* 41(3):187-191.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, isolation, neurotransmitter, dopaminergic, noradrenergic, serotonergic.

Olsson, T., A.H. Mohammed, L.F. Donaldson, B.G. Henriksson, and J.R. Seckl (1994). **Glucocorticoid receptor and NGFI-A gene expression are induced in the hippocampus after environmental enrichment in adult rats.** *Molecular Brain Research* 23(4):349-353.
Descriptors: rat, adult, nerve growth factor, hippocampus, mineralocorticoid receptor, transcription factor.

Ough, B.R., W.W. Beatty, and J. Khalili (1972). **Effects of isolated and enriched rearing on response inhibition.** *Psychonomic Science* 27(5):293-294.
Descriptors: rat, environmental enrichment, isolation, DRL-20 task, food reward, CRF.

Pacteau, C., D. Einon, and J. Sinden (1989). **Early rearing environment and dorsal hippocampal ibotenic acid lesions: Long-term influences on spatial learning and alternation in the rat.** *Behavioral Brain Research* 34(1-2):79-96.
Descriptors: rat, female, weanling, environmental enrichment, social isolation, chemical vs. electrical lesions, learning.

Panksepp, J. (1981). **The ontogeny of play in rats.** *Developmental Psychobiology* 14(4):327-332.
NAL call number: QP351 D4
Descriptors: rat, Long-Evans, weaning, young, pinning behavior, isolation, dominance.

Pappas, B.A., M. Saari, J. Smythe, S. Murtha, et al.. **Forebrain norepinepherine and neurobehavioral plasticity: Neonatal 6-hydroxydopamine eliminates enriched-impoverished experience effects on maze performance.** *Pharmacology, Biochemistry, and Behavior* 27(1):153-158.
NAL call number: QP901 P4
Descriptors: rat, male newborn, weanling, 6-OHDA, maturation, Lashley maze, Hebb-Williams maze.

Pappas, B.A., G. Vickers, J. Gallivan, and M. Buxton (1981). **Neuro-pharmacological and environmental (home cage bedding) influences on infant rat activity.** *Progress in Neuro-Psychopharmacology* 5(3):307.
Descriptors: rat, neonate, abstract.

Pappas, B.A., S.J.E. Murtha, G.A.S. Park, K.T. Condon, R.M. Szirtes, S.I. Laventure, and A. Ally (1992). **Neonatal brain dopamine depletion and the cortical and behavioral consequences of enriched postweaning environment.** *Pharmacology, Biochemistry, and Behavior* (USA) 42(4):741-748.
NAL call number: QP901 P4
Descriptors: rat, male, water maze, 6-OHDA, cognition.

Pare, W.P. and G.P. Vincent (1989). **Environmental enrichment, running behavior and activity-stress ulcer in the rat.** *Medical Science Research* 17(1):35-36.
Descriptors: rat, hypertensive, Wistar-Kyoto, running wheel, genetics.

Park, G.A.S., B.A. Pappas, S.M. Murtha, and A. Ally (1992). **Enriched environment primes forebrain choline acetyltransferase activity to respond to learning experience.** *Neuroscience Letters* (Ireland) 143(1-2):259-262.
NAL call number: QP351 N3
Descriptors: rat, weanling, water maze, caudate, training.

Parsons, P.J. and N.E. Spear (1972). **Long-term retention of avoidance learning by immature and adult rats as a function of environmental enrichment.** *Journal of Comparative and Physiological Psychology* 80(2):297-303.
NAL call number: 410 J822
Descriptors: rat, Sprague-Dawley, female, weanling, adult, handling, avoidance learning, electric shock, memory.

Pascual, R., V. Fernandez, S. Ruiz, and R.O. Kuljis (1993). **Environmental deprivation delays the maturation of motor pyramids during the early postnatal period.** *Early Human Development* 33(2):145-155.
NAL call number: RG600 E27
Descriptors: rat, Sprague-Dawley, male, female, neonate, morphometrics, pyramidal neurons, dendrites, cortex, malnutrition.

Paylor, R., S.K. Morrison, J.W. Rudy, L.T. Waltrip, and J.M. Wehner (1992). **Brief exposure to an enriched environment improves performance on the Morris water task and increases hippocampal cytosolic protein kinase C activity in the young rat.** *Behavioural Brain Research* 52(1):49-56.
Descriptors: rat, neonate, water maze, hippocampus, protein kinase C, learning, memory.

Pellis, S.M., V.C. Pellis, and M.M. McKenna (1993). **Some subordinates are more equal than others play fighting amongst adult subordinate male rats.** *Aggressive Behavior* 19(5):385-393.
NAL call number: BF575 A3A57
Descriptors: rat, male, dominance, behavior, play.

Pellis, S.M., E. Castaneda, M.M. McKenna, L.T.L. Tran-Nguyen, and I.Q. Whishaw (1993). **The role of the striatum in organizing sequences of play fighting in neonatally dopamine-depleted rats.** *Neuroscience Letters* 158(1):13-15.
NAL call number: QP351 N3
Descriptors: rat, male, female, young, 6-hydroxydopamine, striatum, play fighting, allogrooming, sexual mounting.

Perez, V.J., B.B. Thach, and J.L. Palet (1978). **S-100 protein: Regional CNS concentrations in rats raised in different environments.** *Developmental Psychobiology* 11(4):301-308.
NAL call number: QP351 D4
Descriptors: rat, Holtzman, female, post-weaning, toys, cerebellum, brainstem, protein turnover.

Pogun, S., S. Demirgoren, F.Z. Kutay, and B. Okur (1992). **Learning induces changes in the central cholinergic system of the rat in a sexually dimorphic pattern.** *International Journal of Psychophysiology* 13(1):17-23.
Descriptors: rat, male, female, environmental enrichment, active avoidance learning, muscarinic receptors, acetylcholinesterase, choline acetyltransferase.

Por, S.B., E.L. Bennett, and S.C. Bondy (1982). **Environmental enrichment and neurotransmitter receptors.** *Behavioral and Neural Biology* 34(2):132-140.
NAL call number: QH301 C63
Descriptors: rat, Berkeley S_1, binding assays, membrane fractions, cerebellum, subcortex, cortex.

Potegal, M. and D. Einon (1989). **Aggressive behaviors in adult rats deprived of playfighting experience as juveniles.** *Developmental Psychobiology* 22(2):159-172.
NAL call number: QP351 D4
Descriptors: rat, male, female, littermates, isolation, pairs, mouse-killing, intraspecific aggression, shock-induced fighting, thresholds.

Rabe, A. and R.K. Haddad (1970). **Response of micrencephalic rates to environmental complexity.** *Proceedings of the Annual Convention of the American Psychological Association* 5(Pt.1):195-196.
Descriptors: rat, adult, chemically induced micrencephaly, Hebb-Williams maze.

Ray, O.S. and S. Hochhauser (1969). **Growth hormone and environmental complexity effects on behavior in the rat.** *Developmental Psychobiology* 1(4):311-317.
NAL call number: BF712 D46
Descriptors: rat, female, pregnant, neonate, weanling, bovine growth hormone, reflex maturation, environmental enrichment, isolation, open field, Lashley III maze, shuttle box, learning.

Raynor, T.H., W.H. Steinhagen, and T.E. Hamm, Jr. (1983). **Differences in the microenvironment of a polycarbonate caging system: Bedding vs. raised wire floor.** *Lab Animal* 17(2):85-89.
NAL call number: QL55 A1L3
Descriptors: rat, male, female, caging, bedding, floor type, ammonia, aerosols, temperature, humidity.

Renner, M.J. and M.R. Rosenzweig (1986). **Social interactions among rats housed in group and enriched environments.** *Developmental Psychobiology* 19(4):303-313.
NAL call number: QP351 D4
Descriptors: rat, Berkeley S1, brain weight, behavior, social factors.

Renner, M.J. and C.H. Renner (1993). **Expert and novice intuitive judgements about animal behavior.** *Bulletin of the Psychonomic Society* 31(6):551-552.
Descriptors: rat, environmental enrichment, impoverished, observations, training.

Rethlingshafer, D. and L.R. Arrington (1966). **Problem solving in B1 deficit rats reared in enriched and restricted environments.** *Proceedings of the 74th Annual Convention of the American Psychological Association* 1966:3-4.
Descriptors: rat, vitamin B1, complete diet, Hebb-Williams maze.

Richardson, R., M.A. Siegel, and B.A. Campbell (1988). **Unfamiliar environments impair information processing as measured by behavioral and cardiac orienting response to auditory stimuli in preweanling and adult rats.** *Developmental Psychobiology* 21(5):491-503.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, male, female, weanling, adult, orienting response, auditory stimulus, heart rate, isolation, socially reared.

Rieg, T.S., L.E. Doerries, J.G. O'Shea, and P.F. Aravich (1993). **Water deprivation produces an exercise-induced weight loss phenomenon in the rat.** *Physiology and Behavior* 53(3):607-610.
NAL call number: QP1 P4
Descriptors: rat, Sprague-Dawley, feed restriction, running wheel, body weight, exercise, anorexia nervosa, vasopressin, blood chemistry.

Riege, W.H. and H. Morimoto (1970). **Effects of chronic stress and differential environments upon brain weights and biogenic amine levels in rats.** *Journal of Comparative and Physiological Psychology* 71(3):396-404.
NAL call number: 410 J822
Descriptors: rat, Berkeley S_1, Fischer, tumbling stress, norepinephrine, dopamine, serotonin, environmental enrichment, impoverished, adrenal glands, cortex, hypothalamus, midbrain, brain weight.

Rinck, C. (1968). **The effect of enriched environment and handling on the learning of a visual discrimination task.** *Psychonomic Science* 12(7):317-318.
Descriptors: rat, environmental enrichment, impoverished, handling, emotionality, exploration.

Rockman, G.E. and J.E.M. Gibson (1992). **Effects of duration and timing of environmental enrichment on voluntary ethanol intake in rats.** *Pharmacology, Biochemistry, and Behavior* (USA) 41(4):689-693.
NAL call number: QP901 P4
Descriptors: rat, male, weanling, ethanol.

Rockman, G.E., J.E. Gibson, and A. Benarroch (1989). **Effects of environmental enrichment on voluntary ethanol intake in rats.** *Pharmacology, Biochemistry, and Behavior* 34(3):487-490.
NAL call number: QP901 P4
Descriptors: rat, male, weanling, isolation, water consumption.

Rockman, G.E., T.B. Borowski, and G.B. Glavin (1986). **The effects of environmental enrichment on voluntary ethanol consumption and stress ulcer formation in rats.** *Alcohol* 3(5):299-302.
Descriptors: rat, weanling, immobilization, ulcers.

Rockman, G.E., A.M. Hall, L.E. Market, and G.B. Glavin (1988). **Influence of rearing conditions on voluntary ethanol intake and response to stress in rats.** *Behavioral and Neural Biology* 49(2):184-191.
NAL call number: QH301 C63
Descriptors: rat, male, weanling, immobilization, ulcers.

Rodriguez Enchandia, E.L., A.S. Gonzalez, R. Cabrera, and L.N. Fracchia (1988). **A further analysis of behavioral and endocrine effects of unpredictable chronic stress.** *Physiology and Behavior* 43(6):789-795.
NAL call number: QP1 P4
Descriptors: rat, male, female, depression, emotional stress, physical stress, motor activity, exploration, corticosterone, prolactin.

Rose, F.D., K. al-Khamees, M.J. Davey, and E.A. Attree (1993). **Environmental enrichment following brain damage: An aid to recovery or compensation?** *Behavioural Brain Research* 56(1):93-100.
Descriptors: rat, prelesion performance vs. postlesion performance, water maze, escape response, bilateral occipital lesions.

Rose, F.D., M.J. Davey, and E.A. Attree (1993) **How does environmental enrichment aid performance following cortical injury in the rat?** *Neuroreport* 4(2):163-166.
Descriptors: rat, cortex, brain damage, water maze, learning.

Rose, F.D., M.J. Davey, K. Al-Khamees, and E.A. Attree (1992). **General adaptive capacity and recovery of function following cortical damage in the rat.** *Medical Science Research* 20(10):359-360.
Descriptors: rat, bilateral lesions, occipital cortex, water maze, environmental enrichment, learning.

Rose, F.D., M.J. Davey, S. Love, and P.A. Dell (1987). **Environmental enrichment and recovery from contralateral sensory neglect in rats with large unilateral neocortical lesions.** *Behavioural and Brain Research* 24(3):195-202.
Descriptors: rat, compensation vs. recovery, bracelet removal test, postoperative.

Rose, F.D., P.A. Dell, and S. Love (1987). **An analysis of reinforcement in rats reared in enriched and impoverished environments.** *Medical Science Research: Psychology and Psychiatry* 15(9-12):717-718.
Descriptors: rat, male, Lister hooded, reward, behavior, operant learning.

Rose, F.D., P.A. Dell, and S. Love (1985). **Behavioural consequences of different types of environmental enrichment in the rat.** *IRCS Medical Science* 13(8):748-749.
Descriptors: rat, behavior, methods.

Rose, F.D., P.A. Dell, S. Love, and M.J. Davey (1989). **Post-surgical environmental enrichment and functional recovery in the hemidecorticate rat: Alternative interpretations.** *Medical Science Research* 17(11):481-483.
Descriptors: rat, male, open field test, attention test, grip test, new learning vs. established learning.

Rose, F.D., P.A. Dell, S. Love, and M.J. Davey (1988). **Environmental enrichment and recovery from a complex G0/No-Go reversal deficit in rats following large unilateral neocortical lesions.** *Behavioural Brain Research* 31(1):37-45.
Descriptors: rat, operant task, behavior, hemidecorticate deficit.

Rose, F.D. and P.J. Lamden (1983). **GO NO-GO learning in rats reared in enriched and impoverished environments.** *IRCS Medical Science: Psychology and Psychiatry* 11(5-6):433-434.
Descriptors: rat, Hooded Lister, male, auditory discrimination, learning.

Rose, F.D., S. Love, and P.A. Dell (1986). **Differential reinforcement effects in rats reared in enriched and impoverished environments.** *Physiology and Behavior* 36(6):1139-1145.
NAL call number: QP1 P4
Descriptors: rat, learning, lever-press training, response-contingent events.

Rose, F.D., S. Love, P.A. Dell, and M.J. Davey (1988). **Environmental attenuation of DRL performance in the rat following hemidecortication.** *Medical Science Research* 16(11):563-564.
Descriptors: rat, male, Skinner box, differential reinforcement, error inhibition.

Rosenzweig, M.R. and E.L. Bennett (1972). **Cerebral changes in rats exposed individually to an enriched environment.** *Journal of Comparative and Physiological Psychology* 80(2):304-313.
NAL call number: 410 J822
Descriptors: rat, Berkeley S_1, male, methamphetamine, brain weight, brain enzymes, light vs. dark.

Rosenzweig, M., E.L. Bennett, and M.C. Diamond (1972). **Cerebral effects of differential experience in hypophysectomized rats.** *Journal of Comparative and Physiological Psychology* 79(1):56-66.
NAL call number: 410 J822
Descriptors: rat, Fischer, Long-Evans, male, environmental enrichment, impoverished, brain weight, cortex, lesions, acetylcholinesterase, cholinesterase, pituitary.

Sanchez-Toscano, F., M.M. Sanchez, and J. Garzon (1991). **Changes in the number of dendritic spines in the medial preoptic area during a premature long-term social isolation in rats.** *Neuroscience Letters* 122(1):1-3.
NAL call number: QP351 N3
Descriptors: rat, male, neonates, premature weaning, Golgi study, dendrites, isolation, postsynaptic structures, stress.

Satinder, K.P. (1967). **Effects of bedding material on survival probability, body weight and open-field behaviour in rat.** *Psychological Reports* 21(3):954-956.
Descriptors: rat, female, learning, behavior.

Schaefer, G.J. and R.P. Michael (1991). **Housing conditions alter the acquisition of brain self-stimulation and locomotor activity in adult rats.** *Physiology and Behavior* 49(3):635-638.
NAL call number: QP1 P4
Descriptors: rat, male, electrodes, medial forebrain bundle, lateral hypothalamus, group reared, isolation, handling, locomotion, unconditioned behavior.

Schmorrow, D.D. and R.E. Ulrich (1991). **Improving the housing and care of laboratory pigeons and rats.** *Humane Innovations and Alternatives* 5:299-305.
NAL call number: QL55 H8
Descriptors: rat, caging, space requirements, animal welfare.

Schuster, R., B.D. Berger, and H.H. Swanson (1994). **Cooperative social coordination and aggression: II. Effects of sex and housing among three strains of intact laboratory rats differing in aggressiveness.** *Quarterly Journal of Experimental Psychology (B):Comparative and Physiological Psychology* 46(4):367-390.
Descriptors: rat, S3, Charles River, Wistar, synchronized shuttling, pair housing, isolation, behavior, learning.

Schwandt, L.M. (1993). **Individual versus group housing affects nociception independently of housing status during development.** *Bulletin of the Psychonomic Society* 31(6):525-528.
Descriptors: rat, isolation, housing, pain reception, electric shock, stress-induced hypoalgesia, stress.

Selseth, K.J. and E.D. Kemble (1988). **Fluprazine hydrochloride decreases play behavior but not social grooming in juvenile male rats.** *Bulletin of the Psychonomic Society* 26(6):563-564.
Descriptors: rats, male, young, attack, male copulation, maternal behavior, fear.

Seybold, K.S., P. Wampler-Parsons, H.A. Murphy, R. Magee, and R.L. Port (1993). **Modest environmental enrichment improves cognitive performance of aged rats.** *Society for Neuroscience Abstracts* 19(1-3):600.
NAL call number: QP351 S6
Descriptors: rat, old, behavior, memory.

Sharp, P.E., C.A. Barnes, and B.L. McNaughton (1987). **Effects of aging on environmental modulation of hippocampal evoked responses.** *Behavioral Neuroscience* 101(2):170-178.
NAL call number: QP351 B45
Descriptors: rat, young, old, dentate gyrus, evoked responses.

Siegel, M.A. and R.A. Jensen (1986). **The effects of naloxone and cage size on social play and activity in isolated young rats.** *Behavioral and Neural Biology* 45(2):155-168.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, male, young, pinning behavior, socialization, activity, play behavior.

Sirevaag, A.M., J.E. Black, D. Shafron, and W.T. Greenough (1988). **Direct evidence that complex experience increases capillary branching and surface area in visual cortex of young rats.** *Developmental Brain Research* 43(2):299-304.
Descriptors: rat, adolescent, toys, enrichment, angiogenesis.

Siviy, S.M. and J. Panksepp (1987). **Sensory modulation of juvenile play in rats.** *Developmental Psychobiology* 20(1):39-55.
NAL call number: QP351 D4
Descriptors: rat, Long-Evans, somatosensory input, xylocaine, local anesthesia, dorsal body, pinning, play motivation.

Siviy, S.M. and D.M. Atrens (1992). **The energetic costs of rough-and-tumble play in the juvenile rat.** *Developmental Psychobiology* 25(2):137-148.
NAL call number: QP351 D4
Descriptors: rat, young, indirect calorimetry, energy expenditure, play, play restricted, body weight, feed consumption.

Slagle, R.W. (1969). **The effects of specialized environmental enrichment on brain and behavior of rats.** *Dissertation Abstracts* 29(9-B):3518.
NAL call number: Z5055.U49D53
Descriptors: rat, environmental enrichment.

Slentz, C.A. and J.O. Holloszy (1993). **Body composition of physically inactive and 25-month-old female rats.** *Mechanisms of Aging and Development* 69(3):161-166.
NAL call number: QP84 M4
Descriptors: rat, Long-Evans, female, isolation, running wheel, feed intake, body fat, body mass, body protein, body weight.

Smart, J.L., A.C. McMahon, R.F. Massey, G.-N.K. Akbar, and M.A. Warren (1990). **Evidence of non-maternally mediated acceleration of eye-opening in "enriched" artificially reared pups.** *Developmental Brain Research* (Netherlands) 56(1):141-143.
Descriptors: rat, neonates, eye-opening, gentling, social interaction, homing.

Smith, H.V. (1972). **Effects of environmental enrichment on open field activity and Hebb-Williams problem solving in rats.** *Journal of Comparative and Physiological Psychology* 80(1):163-168.
NAL call number: 410 J822
Descriptors: rat, Carworth Europe, male, female, impoverished, test order, activity, defecation, maze, exploration.

Sokolov, V.E. and S.A. Kvashnin (1993). **Play behavior in the Turkestan rat, *Rattus turkestanicus*.** *Zoologiceskij zurnal* 72(6):124-129.
NAL call number: 410 R92
Descriptors: rat, Turkestan, activity, dominance.

Sokolov, V.E. and S.A. Kvashnin (1993). **A comparative study of play behavior in 3 species of rattus (Rodentia, Muridae).** *Zoologichesky Zhurnal* 72(11):126-139.
NAL call number: 410 R92
Descriptors: rat, Norwegian, Black, Turkestan, male, female, age.

Sokolov, V.E. and S.A. Kvashnin (1993). **Play behavior in the black rat, *Rattus rattus*.** *Zoologiceskij zurnal* 72(5):132-141.
NAL call number: 410 R92
Descriptors: rat, Black, male, female, age, behavior, activity.

Speiler, K., P. Schoch, J.R. Martin, and W. Haefely (1993). **Environmental stimulation promotes changes in the distribution of phorbol ester receptors.** *Pharmacology, Biochemistry, and Behavior* 46(3):553-560.
NAL call number: QP901 P4
Descriptors: rat, female, protein kinase C, learning, memory, [^{3}H]-PDBu, receptor binding, cortex, hippocampus, radial maze, environmental enrichment.

Spencer, P.J., J.L. Mattsson, K.A. Johnson, and R.R. Albee (1993). **Neurotoxicity screening methods are sensitive to experimental history**. *International Journal of Psychophysiology* 14(1):5-19.
Descriptors: rat, exercise, handling, neurotoxicity, evoked potentials, motor activity, histopathology.

Strupp, B.J. and D.A. Levitsky (1984). **Social transmission of food preferences in adult hooded rats (*Rattus norvegicus*).** *Journal of Comparative Psychology* 98(3):257-266.
NAL call number: BF671 J6
Descriptors: rat, Long-Evans, hooded, male, social learning.

Sturgeon, R.D. and L.D. Reid (1971). **Rearing variations and Hebb-Williams maze performance.** *Psychological Reports* 29(2):571-580.
Descriptors: rat, hooded, male, weanling, young, environmental enrichment, impoverished, pretraining, problem solving.

Sucheki, D., P. Rosenfield, and S. Levine (1993). **Maternal regulation of the hypothalamic-pituitary-adrenal axis in the infant rat: The role of feeding and stroking.** *Developmental Brain Research* 75(2):185-192.
Descriptors: rat, female, neonate, corticosterone, maternal separation, feeding, stroking.

Susser, E.R. and R.B. Wallace (1982). **The effects of environmental complexity on the hippocampal formation of the adult rat.** *Acta Neurobiologiae Experimentalis* 42(2):203-207.
NAL call number: 442.8 AC8
Descriptors: rat, Long-Evans, male, dorsal hippocampus, brain weight, granule cells, plasticity.

Swanson, H.H., et al. (1983). **Interaction between pre-weaning undernutrition and post-weaning environmental enrichment on somatic development and behaviour in male and female rats.** *Behavioural Processes* 8(1):1-20.
NAL call number: QL750 B4
Descriptors: rat, Wistar, male, female, neonate, young, growth, sexual maturation, behavior, brain weight, toys.

Swanson, H.H. and N.E. Van De Poll (1983). **Effects of an isolated or enriched environment after handling on sexual maturation and behavior in male and female rats.** *Journal of Reproduction and Fertility* 69:165-171.
NAL call number: 442.8 J8222
Descriptors: rat, Wistar, male, female, handling, toys, ladders, ropes, tubes, isolation, socially reared, behavior, sexual behavior, body weight, organ weight.

Symons, L.A. and R.C. Tees (1990). **An examination of the intramodal and intermodal behavioral consequences of long-term vibrissae removal in rats.** *Developmental Psychobiology* 23(8):849-867.
NAL call number: QP351 D4
Descriptors: rat, male, environmental enrichment, cauterization vs. plucking, tactile stimuli, visual stimuli.

Tachibana, T. (1979). **Effects of early nutritional and environmental conditions on later runway test behavior in rats.** *Japanese Psychological Research* 21(2):99-102.
Descriptors: rat, Sprague-Dawley, malnutrition, environmental enrichment, isolation, runway.

Tagney, J. (1973). **Sleep patterns related to rearing rats in enriched and impoverished environments.** *Brain Research* 53:353-361.
NAL call number: Film S-1779
Descriptors: rat, male, weanling, electro-oculogram, EEG, EMG, slow wave, REM.

Takahashi, L.K., C. Haglin, and N.H. Kalin (1992). **Prenatal stress potentiates stress-induced behavior and reduces the propensity to play in juvenile rats.** *Physiology and Behavior* 51(2):219-323.
NAL call number: QP1 P4
Descriptors: rat, male, female, siblings, juvenile, social play, foot shock, tonic immobility, corticosteroids.

Tanabe, G. (1972). **Remediating maze deficiencies by the use of environmental enrichment.** *Developmental Psychology* 7(2):224.
NAL call number: BF712 D46
Descriptors: rat, Wistar, male, female, pregnancy, lactation, malnutrition, isolation, learning.

Taylor, A.J., S. Gordon, and R.D. Tee (1994). **Influence of bedding, cage design, and stock density on rat urinary aeroallergen levels.** *American Journal of Industrial Medicine* 25(1):89.
Descriptors: rat, allergens, occupational exposure.

Thor, D.H. and W.R. Holloway (1984). **Developmental analyses of social play behavior in juvenile rats.** *Bulletin of the Psychonomic Society* 22(6):587-590.
Descriptors: rat, male, female, ontogenetic descriptions, rough and tumble play, sexual maturity, aggression.

Tobin, B.W., J.L. Beard, and W.L. Kenney (1993). **Exercise training alters feed efficiency and body composition in iron deficient rats.** *Medicine and Science in Sports and Exercise* 25(1):52-59.
Descriptors: rat, training, exercise, growth, diet.

Uylings, H.B., K. Kuypers, M.C. Diamond, W.A. Veltman (1978). **Effects of differential environments on plasticity of dendrites of cortical pyramidal neurons in adult rats.** *Experimental Neurology* 62(3):658-677.
NAL call number: RC321.E96
Descriptors: rat, male, Berkeley S_1, cortex, dendrites, length, branching, environmental enrichment.

Van Gool, W.A. and M. Mirmiran (1986). **Effects of aging and housing in an enriched environment on sleep-wake patterns in rats.** *Sleep* 9(2):335-347.
Descriptors: rat, male, adult, old, slow wave, desynchronized sleep, adaptation.

Van Gool, W.A., M. Mirmiran, and F. Van Haaren (1985). **Spatial memory and visual evoked potentials in young and old rats after housing in an enriched environment**. *Behavioral and Neural Biology* 44(3):454-469.
NAL call number: QH301 C63
Descriptors: rat, adult, old, radial maze, paired flashes, visual sensitivity, hippocampal changes.

Van Gool, W.A., H.F. Pronker, M. Mirmiran, and H.B.M. Uylings (1987). **Effect of housing in an enriched environment on the size of the cerebral cortex in young and old rats.** *Experimental Neurology* 96(1):225-232.
NAL call number: RC321 E96
Descriptors: rat, adult, old, caging, toys, cortical plasticity.

Van Haaren, F.P., and A. Van Hest (1987). **Old, but not worn out. [Oud, maar niet versleten.] Special Issue: The elderly and psychology.** *Psycholoog* 22(11):510-513.
Descriptors: rat, adult, aging, environmental enrichment, social deprivation, memory loss, problem solving, circadian activity.

Venable, N., V. Fernandez, E. Diaz, and T. Pinto-Hamuy (1989) **Effects of preweaning environmental enrichment on basilar dendrites of pyramidal neurons in occipital cortex: A Golgi study.** *Developmental Brain Research* 49(1):140-144.
Descriptors: rat, neonates, cortical dendrites, Golgi-Cox-Sholl stain.

Venable, N., T. Pinto-Hamuy, J.A. Arraztoa, M.T. Contador, A. Chellew, C. Peran, and X. Valenzuela (1988). **Greater efficacy of preweaning than postweaning environmental enrichment on maze learning in adult rats.** *Behavioural Brain Research* 31(1):89-92.
Descriptors: rat, adult, Hebb-Williams maze, development.

Vore, D.A. and D.R. Ottinger (1970). **Maternal food restriction: Effects on offspring development, learning, and a program of therapy.** *Developmental Psychology* 3(3, Pt.1):337-342.
NAL call number: BF712 D46
Descriptors: rat, Purdue Wistar, female, malnutrition, estrus, gestation, lactation, foster mothers, body weight, T-maze, Hebb-Williams maze.

Walker, J.P. (1973). **The effects of enriched environment and isolation upon catecholamine metabolism in various brain regions.** *Dissertation Abstracts International* 33(9-B):4497.
NAL call number: Z5055.U49D53
Descriptors: rat, hypothalamus, cerebellum, caudate nucleus.

Wallace, R.J. (1988). **Latency measures indicate new place neophobia in *Rattus* species.** *Behavioural Processes* 17(1):63-67.
NAL call number: QL750 B4
Descriptors: rat, novel places, exploration, home cage, lighting.

Weldon, D.A. and C.J. Smith (1979). **Superior colliculis lesions and environmental experience: Nonvisual effects on problem solving and locomotor activity.** *Physiology and Behavior* 23(1):159-165.
NAL call number: QP1 P4
Descriptors: rat, Long-Evans, bilateral lesions, environmental enrichment, closed field, open field, illumination, vision.

Wells, A.M. **The effect of dietary and environmental conditions on performance of rats in the Hebb-Williams maze.** *Dissertation Abstracts International* 32(1-B):600-601.
NAL call number: Z5055.U49D53
Descriptors: rat, neonate, environmental enrichment, impoverished.

Wells, A.M., C.R. Geist, and R.R. Zimmerman (1972). **Influence of environmental and nutritional factors on problem solving in the rat.** *Perceptual and Motor Skills* 35(1):235-244.
Descriptors: rat, Holtzman, male, neonate, foster mothers, dietary protein, environmental enrichment, spatial, visual, tactile, impoverished, Hebb-Williams maze.

Whishaw, I.Q., R.J. Sutherland, B. Kolb, and J.B. Becker (1986). **Effects of neonatal forebrain noradrenaline depletion on recovery from brain damage: Performance on a spatial navigation task as a function of age of surgery and postsurgical housing.** *Behavioral and Neural Biology* 46(3):285-307.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, neonate, adult, hemidecortication, noradrenaline, environmental enrichment.

Whishaw, I.Q., J.-A. Zaborowski, and B. Kolb (1984). **Postsurgical enrichment aids adult hemidecorticate rats on a spatial navigation task.** *Behavioral and Neural Biology* 42(2):183-190.
NAL call number: QP351 B45
Descriptors: rat, neonate, adult, cortex, Morris water maze, outdoors.

White, W.J. and A.M. Mans (1984). **Effect of bedding changes and room ventilation rates on blood and brain ammonia levels in normal rats and rats with portacaval shunts.** *Laboratory Animal Science* 34(1):49-52.
NAL call number: 410.9 P94
Descriptors: rat, Long-Evans, male, bedding, air pollution.

White, N.R. and R.J. Barfield (1989). **Playback of female rat ultrasonic vocalizations during sexual behavior.** *Physiology and Behavior* 45(2):229-233.
NAL call number: QP1 P4
Descriptors: rat, female, male, devocalized, intact, darting.

Widman, D.R., G.C. Abrahamsen, and R.A. Rosellini (1992). **Environmental enrichment: The influences of restricted daily exposure and subsequent exposure to uncontrollable stress.** *Physiology and Behavior* 51(2):309-318.
NAL call number: QP1 P4
Descriptors: rat, male, stress, operant tasks, pavlovian tasks, learning.

Widman, D.R. and R.A. Rosellini (1990). **Restricted daily exposure to environmental enrichment increases the diversity of exploration.** *Physiology and Behavior* 47(1):57-62.
NAL call number: QP1 P4
Descriptors: rat, male, object exploration test, environmental exposure.

Will, B.E., et al. (1977). **Relatively brief environmental enrichment aids recovery of learning capacity and alters brain measures after postweaning brain lesions in rats.** *Journal of Comparative and Physiological Psychology* 91(1):33-50.
NAL call number: 410 J822
Descriptors: rat, Fischer, Berkeley S_1, male, bilateral lesions, occipital cortex, hippocampus, Hebb-Williams maze, methamphetamine, brain weight, RNA, DNA.

Will, B., C. Kelche, and F. Deluzarche (1981). **Effects of post-operative environment on functional recovery after entorhinal cortex lesions in the rat.** *Behavioral and Neural Biology* 33(3):303-316.
NAL call number: QH301 C63
Descriptors: rat, young, bilateral lesions, entorhinal cortex, Hebb-Williams maze, learning.

Will, B.E., F. Deluzarche, and C. Kelche (1983). **Does post-operative environment attenuate or exacerbate symptoms which follow hippocampal lesions in rats?** *Behavioural Brain Research* 7(1):125-132.
Descriptors: rat, hooded, female, spontaneous alternation, hippocampus.

Witvitskaya, L.V. (1983). **DNA synthesis in the brain of rats bred in sensorily enriched or impoverished environment.** *Zhurnal Vysshei Nervnoi Deyatel'nosti* 33(4):773-775.
Descriptors: rat, deprivation, brain, biochemistry.

Wolffgram, J. and A. Heyne (1991). **Social behavior, dominance, and social deprivation of rats determine drug choice.** *Pharmacology, Biochemistry, and Behavior* 38(2):389-399.
Descriptors: rat, Wistar, male, adult, ethanol, diazepam, quinine, open field, isolation, group housing, activity, body weight.

Wong, P.T.P., T. Roach, and B. Osborne (1975). **A sand-digging apparatus for rats.** *Behavior Research Methods and Instrumentation* 7(1):34-36.
Descriptors: rat, recording device, digging behavior, time.

Wu, S.Y.C. (1973). **Effects of enriched environment and visual deprivation on development of brain in rat.** *Acta Psychologica Taiwanica* 15:154-160.
Descriptors: rat, Berkeley S_1, neonate, brain weight, cortex, superior colliculi, acetylcholinesterase, butyrylcholinesterase.

Yamamoto, Y., T. Nakaya, and S. Kato (1988). **Influences of early rearing environment on Hebb-Williams maze learning in the rat: A comparison among group/imposed rich stimulation, group/poor stimulation, and isolation/poor stimulation.** *Annual of Animal Psychology* 37(2):99-114.
Descriptors: rat, weanling, adolescent, sensory stimuli, Hebb-Williams maze, learning.

Yeterian, E.H. and W.A. Wilson (1976). **Cross-modal transfer in rats following different early environments.** *Bulletin of the Psychonomic Society* 7(6):551-553.
Descriptors: rat, black-hooded, male, weanling, cross-modal transfer, visual discrimination, learning.

Zendzian-Piotrowska, M. and J. Gorski (1993). **Metabolic adaptation to daily exercise of moderate intensity to exhaustion in the rat.** *European Journal of Applied Physiology and Occupational Physiology* 67(1):77-82.
Descriptors: rat, male, treadmill, training, body mass, feed intake, glycogen, muscle fibers, heart, diaphragm, liver, hypoglycemia, urea.

Zimmerberg-Glick, B. and M.B. Brett (1992). **Effects of early environmental experience on self-administration of amphetamine and barbital.** *Psychopharmacology* (Germany) 106(4):474-478.
Descriptors: rat, male, female, social isolation, self-administration, d-amphetamine sulfate, sodium barbital.

WILD RODENTS

Christisen, D.M. (1985). **Seasonal tenancy of artificial nest structures for tree squirrels.** *Transactions of the Missouri Academy of Science* 19:41-48.
NAL call number: QC180 A1M52
Descriptors: tree squirrels (*Sciurus sp.*), den boxes, tire nest structures, housing.

Cooper, J.J. and C.J. Nichol (1991). **Stereotypic behaviour affects environmental preference in bank voles, *Clethrionomys glareolus*.** *Animal Behaviour* 41(6):971-977.
NAL call number: 410 B77
Descriptors: bank vole, preference test, perception, aversive conditions.

Escherich, P.C. (1981). **Social biology of the bushy-tailed woodrat, *Neotoma cinerea*.** *Publications in Zoology* 110:132pp.
NAL call number: 500 C125Z v.110
Descriptors: Bushy-tailed wood rat, social behavior.

Faulkes, C.G. and D.H. Abbott (1993). **Evidence that primer pheromones do not cause social suppression of reproduction in male and female naked mole-rats (*Heterocephalus glaber*).** *Journal of Reproduction and Fertility* 99(1):225-230.
NAL call number: 442.8 J8222
Descriptors: naked mole-rats, male, female, chemical cues, reproductive suppression, olfactory cues, gustatory contact, luteal phase, androgens.

Murphey, R.M., J.S. Mariano, and F.A. Duarte (1985). **Behavioral observations in a capybara colony (*Hydrochoerus hydrochaeris*).** *Applied Animal Behaviour Science* 14(1):89-98.
NAL call number: QL750 A6
Descriptors: capybara, alarm response, flight or fight response, behavior.

Ödberg, F.O. (1987). **The influence of cage size and environmental enrichment on the development of stereotypies in bank voles (*Clethrionomys glareolus*).** *Behavioural Processes* 14(2):155-173.
Descriptors: bank voles, behavior, conflicts.

Renner, M.J. and M.R. Rosenzweig (1987). **The golden-mantled ground squirrel (*Spermophilus lateralis*) as a model for the effects of environmental enrichment in solitary animals.** *Developmental Psychobiology* 20(1):19-24.
NAL call number: QP351 D4
Descriptors: ground squirrel, brain weight, behavior, social factors.

Rushen, J. (1993). **The "coping" hypothesis of stereotypic behavior.** *Animal Behaviour* 45(3):613-615.
NAL call number: 410 B77
Descriptors: bank voles (*Clethrionomys glareolus*), environmental enrichment, impoverished, perceptions, adverse environments.

Shiga, J., K. Yamamoto, M. Ito, K. Koshimizu (1989). **Breeding and care for wild woodchucks (*Marmota monax*) by indoor and outdoor housing.** *Jikken Dobutsu* 38(2):155-158.
NAL call number: QL55 J55
Descriptors: woodchuck, Japanese, English abstract, housing, reproduction.

Vogt, F.D. and P. Kakooza (1993). **The influence of nest sharing on the expression of daily torpor in the white-footed mouse.** *Canadian Journal of Zoology* 71(7):1297-1302.
NAL call number: 470 C16D
Descriptors: white-footed mouse (*Peromyscus leucopus noveboracensis*), huddling, isolation, radiotelemetry, body temperature, frequency of torpor, euthermic.

Wallace, J. (1994). **Evolution of ground squirrel housing at Biosciences Animal Service, University of Alberta.** *Canadian Association for Laboratory Animal Science/ L'Association Canadienne pour la Technologie des Animaux de Laboratoire Newsletter* 28(4):109-118.
NAL call number: SF405.5 C36
Descriptors: ground squirrel, housing, social groups, burrows, nests, vocalization, visual communication, tactile communication, olfactory communication.

JOURNAL LISTING

The following is a partial listing of journals that contain environmental enrichment and/or behavior articles covering the various species listed.

CATS, DOGS, RABBITS

Title: *American Journal of Veterinary Research* (American Veterinary Medical Association).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0002-9645
Descriptors: veterinary medicine periodicals.
NAL Call Number: 41.8 Am3A
Databases Indexed In: AGRICOLA, CAB ABSTRACTS, AGRIS

Title: *Animal Behaviour* (Association for the Study of Animal Behaviour).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3472
Descriptors: animal behavior periodicals.
NAL Call Number: 410 B77
Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).
Place of Publication: United Kingdom, Wales
Language: English
International Standard Serial Number: 0264-4754
Descriptors: laboratory animals periodicals.
NAL Call Number: QL55.I5
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Anthrozoos* (Delta Society).
Place of Publication: United States, New Hampshire
Language: English
International Standard Serial Number: 0892-7936
Descriptors: human animal relationships periodicals, pet owners psychology periodicals, animal behavior periodicals.
NAL Call Number: SF411.A57
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Applied Animal Behaviour Science.*
Place of Publication: Netherlands
Language: English
International Standard Serial Number: 0168-1591
Descriptors: animal behavior periodicals, domestic animals periodicals.
NAL Call Number: QL750.A6
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Companion Animal Practice.*
Place of Publication: United States, California
Language: English
International Standard Serial Number: 0894-9794
Descriptors: veterinary medicine periodicals, pets diseases periodicals, cats diseases periodicals.
NAL Call Number: SF981.C64
Databases Indexed In: CAB ABSTRACTS, AGRICOLA

Title: *Lab Animal.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0093-7355
Descriptors: laboratory animals periodicals.
NAL Call Number: QL55.A1L33

Databases Indexed In: AGRICOLA, AGRIS

Title: *Laboratory Animal Science* (American Association for Laboratory Animal Science).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0023-6764
Descriptors: laboratory animals periodicals.
NAL Call Number: 410.9 P94
Databases Indexed In: CAB ABSTRACTS, AGRICOLA, AGRIS

Title: *The Veterinary Clinics of North America.*
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0091-0279
Descriptors: veterinary medicine collected works.
NAL Call Number: SF601.V523
Databases Indexed In: MEDLINE, CAB ABSTRACTS, AGRICOLA

Title: *The Veterinary Record: Journal of the British Veterinary Association.*
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0042-4900
Descriptors: veterinary medicine periodicals.
NAL Call Number: 41.8 V641
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Veterinary Technician.*
Place of Publication: United States, New Jersey
Language: English
International Standard Serial Number: Invalid :0196-1764
Descriptors: allied health personnel periodicals, laboratory animal technicians periodicals, veterinary medicine periodicals.
NAL Call Number: SF406.A5
Databases Indexed In: CAB ABSTRACTS

FARM ANIMALS

Title: *Animal Production* (British Society of Animal Production).
Place of Publication: United Kingdom, England
Language: English

International Standard Serial Number: 0003-3561
Descriptors: Livestock-Periodicals, Animal-Industry-Great-Britain
NAL Call Number: 49 An55
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Applied Animal Behaviour Science.*
Place of Publication: Netherlands
Language: English
International Standard Serial Number: 0168-1591
Descriptors: animal behavior periodicals, domestic animals periodicals.
NAL Call Number: QL750.A6
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *British Poultry Science* (Poultry Education Association).
Place of Publication: United Kingdom, Scotland
Language: English
International Standard Serial Number: 0007-1668
Descriptors: poultry periodicals.
NAL Call Number: 47.8 B77
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Canadian Journal of Animal Science* (Canadian Society of Animal Production).
Place of Publication: Canada, Ontario
Language: Includes Some Text in French, Abstracts in English and French

International Standard Serial Number: 0008-3984
Descriptors: animal industry periodicals.
NAL Call Number: 41.8 C163
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Journal of Animal Science* (American Society of Animal Science).
Place of Publication: United States, Wisconsin
Language: English
International Standard Serial Number: 0021-8812
Descriptors: livestock periodicals, animal culture periodicals.
NAL Call Number: 49 J82
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Journal of Dairy Science* (American Dairy Science Association).
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0022-0302
Descriptors: dairying periodicals.
NAL Call Number: 44.8 J822
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Poultry Science* (Poultry Science Association).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0032-5791
Descriptors: poultry periodicals.
NAL Call Number: 47.8 Am33p
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

MICE and RATS

Title: *Animal Behaviour* (Association for the Study of Animal Behaviour).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3472
Descriptors: animal behavior periodicals.
NAL Call Number: 410 B77
Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).
Place of Publication: United Kingdom, Wales
Language: English
International Standard Serial Number: 0264-4754
Descriptors: laboratory animals periodicals.
NAL Call Number: Q155.I5
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Behavioral and Neural Biology.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0163-1047
Descriptors: animal behavior periodicals, neurobiology periodicals.
NAL Call Number: QH301.C63
Databases Indexed In: MEDLINE, BIOSIS, PASCAL, CAB ABSTRACTS

Title: *Behavioral Ecology and Sociobiology.*
Place of Publication: Germany
Language: English
International Standard Serial Number: 0340-5443
Descriptors: animal behavior periodicals, animal populations periodicals.
NAL Call Number: QL751.B4
Databases Indexed In: BIOSIS, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Behavioral Neuroscience* (American Psychological Association).
Place of Publication: United States, District of Columbia
Language: English
International Standard Serial Number: 0735-7044
Descriptors: neuropsychology periodicals, psychology, physiological periodicals, animal behavior periodicals.
NAL Call Number: QP351.B45
Databases Indexed In: PSYCINFO, BIOSIS, PASCAL, MEDLINE, AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Behavioural Brain Research*
Place of Publication: Amsterdam, Netherlands
Language: English
International Standard Serial Number: 0166-4328
Descriptors:
NLM Number: W1 BE135DE
Databases Indexed In: BIOSIS, PSYCINFO

Title: *Biology of Behaviour* (Centre National Recherche Scientifique).
Place of Publication: France
Language: in English or French; Summaries in Both Languages
International Standard Serial Number: 0397-7153
Descriptors: animal behavior, human behavior.
NAL Call Number: Ql750.B52
Databases Indexed In: BIOSIS, PASCAL, CAB ABSTRACTS, AGRIS

Title: *Developmental Psychobiology.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0012-1630
Descriptors: developmental psychobiology periodicals, psychobiology periodicals.
NAL Call Number: QP351.D4
Databases Indexed In: MEDLINE, BIOSIS, PSYCINFO, PASCAL

Title: *Ethology*
Place of Publication: Germany, Berlin
Language: English and German
International Standard Serial Number: 0179-1613
Descriptors: Animal-Behavior-Periodicals, Psychology,-Comparative-Periodicals
NAL Call Number: QL750.E74
Databases Indexed In: LIFE SCIENCES, BIOSIS, PSYCINFO, AGRICOLA

Title: *Journal of Comparative and Physiological Psychology* (American Psychological Association).
Place of Publication: United States, District of Columbia
Language: English
International Standard Serial Number: 0021-9940
NAL Call Number: 410 J822
Databases Indexed In: BIOSIS, MEDLINE, SOCIAL SCISEARCH, CAB ABSTRACTS

Title: *Laboratory Animal Science* (American Association for Laboratory Animal Science).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0023-6764
Descriptors: laboratory animals periodicals.
NAL Call Number: 410.9 P94
Databases Indexed In: CAB ABSTRACTS, AGRICOLA, AGRIS

Title: *Neuropharmacology.*
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0028-3908
Descriptors: neuropharmacology periodicals.
NAL Call Number: RM315.N4
Databases Indexed In: BIOSIS, PSYCINFO

Title: *Pharmacology, Biochemistry and Behavior.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0091-3057
Descriptors: pharmacology periodicals, biological chemistry periodicals, toxicology periodicals.
NAL Call Number: QP901.P4
Databases Indexed In: PSYCINFO, CAB ABSTRACTS

Title: *Physiology and Behavior.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0031-9384
Descriptors: physiology periodicals, psychology, physiological periodicals.
NAL Call Number: QP1.P4
Databases Indexed In: MEDLINE, PASCAL, SOCIAL SCISEARCH, PSYCINFO, CAB ABSTRACTS

Title: *Psychological Record*
Country of Publication: United States, OH
Language: English
International Standard Serial Number: 0033-2933
Descriptors: psychology periodicals
NLM Number: W1 PS632
Databases Indexed In: PSYCINFO, SOCIAL SCISEARCH, BIOSIS

SUBSCRIPTION INFORMATION FOR SELECTED PUBLICATIONS

Animal Ethics Update
A quarterly newsletter for members of animal care and ethics committees published by the Animal Research Review Panel and the Animal Welfare Unit, New South Wales Agriculture, Australia. This publication contains a variety of information on animal welfare topics and practical suggestions for environmental enrichment programs. For information contact Rebecca Larkin, Editor, Animal Welfare Unit, NSW Agriculture, Locked Bag 21, Orange 2800, New South Wales, AUSTRALIA. Tel: (063) 91 3670, Fax: (063) 91 3570, e-mail: larkinr@agric.nsw.gov.au

Animal Keepers' Forum
Monthly journal of the American Association of Zoo Keepers, Inc. contains a regular feature--"Enrichment Options"--which highlights psychological stimulation, behavioral enrichment, activity manipulation, and occupational husbandry in zoo and aquarium environments. Subscription information can be obtained at 635 S.W. Gage Blvd., Topeka, KS (Kansas) 66606-2066 USA. Tel: 1-800-242-4519, Fax: (913) 273-1980.

Animal Technology
A journal published three times a year by the Institute of Animal Technology. Routinely features short articles, technical notes, or reviews pertaining to enriched housing/caging options or enrichment strategies for various laboratory and farm animals including birds and other non-mammalian species. G.E. Ward, Editor, School of Molecular and Medical Biosciences, University of Wales College of Cardiff, P.O. Box 911, Cardiff, Wales CF1 1ST, UK.

Animal Welfare
Quarterly journal produced by Universities Federation for Animal Welfare. "Brings together the results of scientific research and technical studies related to the welfare of animals kept on farms, in laboratories, as companions, in zoos or managed in the wild." Often includes enrichment articles. Subscription information can be obtained from UFAW, 8 Hamilton Close, South Mimms, Potters Bar, Herts, England EN6 3QD, UK. Tel: 0707 658202, Fax: 0707 649279.

Applied Animal Behaviour Science
This journal deals with the behaviour of domesticated and utilized animals. The principal subjects include farm animals (including poultry) and companion animals. Other species covered include rabbits and fur-bearing animals, deer, and animals in forms of confinement

such as zoos, safari parks, and other forms of display. Laboratory animals are occasionally included. Requests regarding subscriptions may be sent to Elsevier Science B.V., Journal Department, P.O. Box 211, 1000 AE Amsterdam, THE NETHERLANDS. Tel: 31-20-4853642, Fax: 31-20-4853598. In the USA and Canada, write to Elsevier Science Inc., Journal Information Center, 655 Avenue of the Americas, New York, NY (New York) 10010, USA. Tel: (212) 633-3750, Fax: (212) 633-3764, Telex: 420-643 AEP UI.

Guide to the Care and Use of Experimental Animals Volume 1, 2nd edition
Published by the Canadian Council on Animal Care in 1993. This publication contains a 40 page section on the social and behavioral requirements of experimental animals including wildlife kept in a laboratory setting. Other sections discuss facilities, the physical environment, occupational health and safety, surgical standards, control of pain, anesthesia, euthanasia, and guidelines for the use of animals in neuroscience research. To obtain a copy of this guide, write to Canadian Council on Animal Care, 1000-151 Slater Street, Ottawa, Ontario K1P 5H3, CANADA.

Lab Animal
This journal is published 11 times a year and emphasizes proper management and care of laboratory animals. It routinely contains articles dealing with environmental enrichment techniques and occasionally devotes an issue to the topic. Last issue of the year is the next year's *Lab Animals Buyers Guide.* Send subscription orders to *Lab Animal* Subscriptions Department, P.O. Box 1710, Riverton, NJ (New Jersey) 08077-7310 USA, Tel: (212) 726-9200.

Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare
The official journal of the Laboratory Animal Science Association, Gesellschaft für Versuchstierkunde, Nederlandse Vereniging voor Proefdierkunde, Schweizerische Gesellschaft für Versuchstierkunde, and the Federation of European Laboratory Animal Science Associations. A quarterly publication devoted to the "advancement of public education in laboratory animal science, technology, and welfare.... The Editorial Board wishes to give especial encouragement to papers describing work which... represents a significant refinement in methodology, leading to improvements in the welfare or well-being of the animals used." Subscription orders should be sent to Publications Subscription Department, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Articles should be sent to Editorial Manager, *Laboratory Animals*, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Tel: 071-290-2923.

The Shape of Enrichment
A quarterly bulletin featuring ideas for environmental and behavioral enrichment written mostly by zoo and aquarium researchers, keepers, and trainers. Topics covered include design and evaluation of enrichment devices and programs. To subscribe write to *The Shape of Enrichment*, 1650 Minden Dr., San Diego, CA (California) 92111-7124 USA. Tel: (619) 231-1515, ext. 4272 or (619) 279-4273, Fax: (619) 279-4208.

ORGANIZATIONS

NORTH AMERICAN RESOURCES:

American Association for Laboratory Animal Science (AALAS)

70 Timber Creek Drive
Cordova, TN (Tennessee) 38018, USA

TELEPHONE: (901) 754-8620
FAX: (901) 753-0046
E-MAIL: info@aalas.org
WORLD WIDE WEB: http://netvet.wustl.edu/aalas.htm
CONTACT: Michael Sondag, Executive Director
TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional
RESOURCES/SERVICES: International in scope. Serves as a clearinghouse for collection and exchange of information on all phases of laboratory animal care and management, use and procurement of laboratory animals used in biomedical research. Educational materials, guides, and audiovisuals. Hold annual meetings that have workshops or seminars on environmental enrichment. Publish *Contemporary Topics* - a bimonthly journal with an expanded peer reviewed section on topics such as clinical management and husbandry. Also publish Laboratory Animal - a monthly, peer reviewed journal covering a diverse array of applied and experimental topics in the laboratory animal sciences.
REQUESTOR: Anyone.
COSTS: Charge for materials (members are charged a lower rate).

American Society of Laboratory Animal Practitioners

University of Texas Medical School
6431 Fannin Street, Room 1132
Houston, TX (Texas) 77030, USA

TELEPHONE: (713) 792-5127
FAX: (713) 792-5127
E-MAIL: bgoodwin@admin4.hsc.uth.tmc.edu
CONTACT: Bradford S. Goodwin, Jr., Secretary-Treasurer
TYPE OF INSTITUTION/ORGANIZATION: Private group of veterinarians
RESOURCES/SERVICES: Personal knowledge of veterinarians.
REQUESTOR: Anyone.
COSTS: None.

Animal Welfare Information Center (AWIC)

Agricultural Research Service
National Agricultural Library
10301 Baltimore Boulevard
Beltsville, MD (Maryland) 20705, USA

TELEPHONE: (301) 504-6212
FAX: (301) 504-7125
E-MAIL: awic@nalusda.gov
WORLD WIDE WEB: http://netvet.wustl.edu/awic.htm
CONTACT: Jean Larson, Coordinator
TYPE OF INSTITUTION/ORGANIZATION: Public, non-profit, government agency
RESOURCES/SERVICES: Vast collection of serials, monographs, and audiovisuals within the National Agricultural Library (NAL). Documents may be borrowed through an interlibrary loan. For more information on document delivery, contact (301) 504-5755. The Center performs brief complimentary searches of AGRICOLA and other relevant databases. The Center can also assist you in formulating your own database searches, provides conference facilities and host training sessions, and can make available speakers and/or a tabletop exhibit for training sessions, conferences, and workshops. The Center produces bibliographies on topics such as stress, analgesia, animal testing alternatives, training materials and other relevant topics to animal welfare. Publishes the *Animal Welfare Information Center Newsletter*.
REQUESTOR: Anyone.
COSTS: All publications are available for free; literature searches on a cost recovery basis; NAL may charge for certain services such as providing photocopies, document delivery, etc.

Canadian Association for Laboratory Animal Science L'Association Canadienne Pour La Technologies des Animaux de Laboratoire

c/o CALAS National Office
Biosciences Animal Service
University of Alberta
Edmonton, Alberta T6G 2E9, CANADA

TELEPHONE: (403) 492-5193
FAX: (403) 492-7257
E-MAIL: dmckay@gpu.srv.ualberta.ca
CONTACT: Donald McKay
TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional

RESOURCES/SERVICES: Produces educational materials, videos, and a monthly newsletter (CALAS/ACTAL Newsletter). Hold annual meetings with workshops, seminars, and poster sessions.
REQUESTOR: Laboratory animal professionals.
COSTS: Vary according to materials.

Canadian Council on Animal Care (CCAC)

350 Albert Street, Suite 315
Ottawa, Ontario K1R 1B1, CANADA
TELEPHONE: (613) 238-4031
FAX: (613) 238-2837
E-MAIL: lroach@bart.ccac.ca
CONTACT: Dr. James Wong, Director of Assessments
TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit
RESOURCES/SERVICES: Establishment and enforcement of standards and guidelines (in Canada) concerning the use of animals in research, testing and teaching. Maintain active, expert committees on all aspects of animal care and use. The Council's program is based on its major publication "Guide to the Care and Use of Experimental Animals," Volume 1, 2nd Edition (1993) and Volume 2 (1984). Within these two documents the subject of environmental enrichment is addressed. CCAC conducts workshops and training courses on various aspects of the care and use of experimental animals, as well as the training of personnel working with these animals. The Council addresses alternative methods and conducts a course on tissue culture. Semi-annually publishes the newsletter, *Resource*.
REQUESTOR: Anyone.
COSTS: Vary according to materials.

Institute of Laboratory Animal Resources (ILAR)

National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. (District of Columbia) 20418, USA
TELEPHONE: (202) 334-2590
FAX: (202) 334-1687
E-MAIL: twolfle@nas.edu
CONTACT: Tom Wolfle
TYPE OF INSTITUTION/ORGANIZATION: ILAR is a unit of the National Research Council's (NRC) Commission on Life Sciences (CLS). The NRC in the working arm of the National Academy of Sciences (NAS), a private, non-governmental, non-profit organization.

RESOURCES/SERVICES: Information on a wide variety of topics related to laboratory animals and emerging adjuncts and alternatives to animal use. Assignments of genetic identification for unique colonies. Guidelines that assist in the implementation of national policies or laws. Information to teachers and students about animals in science and careers in biology. ILAR's information database, which is published as *Animals for Research: A Directory of Sources.* This assists scientists in locating specific animals and models, including nonhuman primates. Produce *ILAR NEWS* - a quarterly journal, available free-of-charge to institutional animal care and use committees, scientists, and veterinarians. Reports specific to nonhuman primates such as *Laboratory Animal Management: Nonhuman Primates*. A study on the well-being of nonhuman primates is currently underway by an ILAR committee. Manage *Animal Models and Genetic Stocks Information Exchange Program.*
REQUESTOR: Anyone.
COSTS: Vary according to materials.

National Library of Medicine (NLM)

8600 Rockville Pike
Bethesda, Maryland 20894, USA

TELEPHONE: (301) 496-6095 or 1-800-272-4787
FAX: (301) 402-1384
E-MAIL: ref@nlm.nih.gov
WORLD WIDE WEB: http://www.nlm.nih.gov/
TYPE OF INSTITUTION/ORGANIZATION: Public
RESOURCES/SERVICES: Library - extensive collection of serials, monographs, audiovisuals can be accessed by anyone. Computer based systems of information retrieval include MEDLARS, MEDLINE, CANCERLIT, AVLINE, TOXLINE, and Grateful Med.
REQUESTOR: Anyone.
COSTS: $7.00 for each filled interlibrary loan.

Scientists Center for Animal Welfare (SCAW)

Golden Triangle Building One
7833 Walker Drive, Suite 340
Greenbelt, Maryland 20770, USA

TELEPHONE: (301) 345-3500
FAX: (301) 345-3503
CONTACT: Lee Krulisch, Executive Director
TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit
RESOURCES/SERVICES: Publications, including conference proceedings, training manuals, and materials from other organizations. Publications - *Canine Research Environment* and *Well-Being of Nonhuman Primates in Research*. Each contains proceedings from conferences sponsored by SCAW.
REQUESTOR: Anyone.
COSTS: Some services are free, others are fee-for-services basis.

The Shape of Enrichment Video Library

c/o Robert Shumaker
Primates
National Zoological Park
Connecticut Ave.
Washington, DC 20008-2598, USA.

CONTACT: Robert Shumaker, Primates (no phone calls)
TYPE OF INSTITUTION/ORGANIZATION: Volunteer, non-profit (not affiliated with the National Zoological Park.)
RESOURCES/SERVICES: Loans videos of environmental enrichment programs currently in place in different zoos, aquariums, etc. around the country. Videos cover a variety of animals. **Donations of videos are encouraged.**

EUROPEAN, ASIAN, and AUSTRALIAN RESOURCES:

Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited (ANZCCART)

P.O. Box 19
Glen Osmond SA 5064
AUSTRALIA

P.O. Box 598
5064 Wellington
NEW ZEALAND

TELEPHONE: 61-08-303-7393 (Australia) 64-04-472-7421(New Zealand)
FAX: 61-08-303-7113 (Australia) 64-04-473-1841(New Zealand)
E-MAIL:anzccart@waite.adelaide.edu.au
WORLD WIDE WEB: http://www.adelaide.edu.au/ANZCCART/
CONTACT: R.M. Baker
TYPE OF INSTITUTION/ORGANIZATION: private, non-profit
RESOURCES/SERVICES: Quarterly newsletter, and other publications on euthanasia, animal care and use committees, wellbeing of research animals, alternatives for undergraduate education, laboratory animal surveys, tumour cell lines available in Australia, humane care and use of animals in research, and animal pain.
REQUESTOR: Anyone.
COSTS: Vary according to materials.

British Laboratory Animals Veterinary Association

Honorary Secretary
C/O Site Services Department
Zeneca Pharmaceuticals
Mereside, Alderly Park
Macclesfield, Cheshire 5K10 4TG, UK

TELEPHONE: 01625 513536
FAX: 01625 583074
CONTACT: D. Whitaker, Honorary Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Slide programs on lab animal diseases, training materials, speakers notes and slides (eg., surgery and anaesthesia), and access to expert advice.
REQUESTOR: Veterinary surgeons with interests in laboratory animal health and welfare.
COSTS: None.

Federation of European Laboratory Animal Science Associations (FELASA)

BCM Box 2989
London WC1N 3XX, UK
CONTACT: P. Hardy, Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.* Sponsors annual animal welfare symposiums.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.

Gesellschaft für Versuchstierkunde Society for Laboratory Animal Science (GV-SOLAS)

C/O Institut für Versuchstierkunde
Pauwelstrasse, D-52074 Aachen
GERMANY

CONTACT: C. Herweg, Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*
REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.

Institute of Animal Technology

c/o University of Liverpool
Faculty of Medicine
Biomedical Services
P.O. Box 147
Liverpool, England L69 3BX, UK

CONTACT: P.A. Hynes, Honorary Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Publishes the quarterly journal *Animal Technology* and the monthly *Bulletin of the Institute of Animal Technology* (Phil Ruddock, Editor, 5 South Parade, Summertown, Oxford OX2 7JL, UK; Tel: 01737 247666). Videos and training manuals on humane care and handling, information on animal welfare.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Institut für Labortierkunde der Universität Zürich
Institute of Laboratory Animal Science

University of Zurich
Winterthurerstrasse 190
8057 Zurich, SWITZERLAND

TELEPHONE: 01 257 11 11 or 01 257 54 51
FAX: 01 257 57 03
CONTACT: Prof. Dr. med. vet. Peter E. Thomann, Director
WORLD WIDE WEB: http://www.unizh.ch/labtier/
TYPE OF INSTITUTION/ORGANIZATION: University
RESOURCES/SERVICES: Provides classes and training courses for technicians, students and postgraduates. Breeds rats and mice, offers diagnostic services for rodents and rabbits, offers in vitro production of monoclonal antibodies, and operates a consulting service to answer questions relating to the care of laboratory animals. Most information on Web site is in German.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Japanese Association for Laboratory Animal Science (JALAS)

2-8-10 Iwamotocho
Chiyoda-ku
Tokyo 101, JAPAN

TELEPHONE/ FAX: 03-3865-1475
RESOURCES: Publishes the quarterly journal *Experimental Animals.*
COSTS: Price of one issue is 2,500 yen (US $25) for non-member individual.

Laboratory Animal Science Assoc. (LASA)

P.O. Box 3993
Tamworth, Staffs B78 3QU, UK

TELEPHONE: 01827 260036
FAX: 01827 260036
CONTACT: B.R. Howard, Honorary Secretary
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*

Nederlandse Vereniging voor Proefdierkunde (NVP)
Dutch Association for Laboratory Animal Science

C/O Agricultural University Wageningen
CKP, P.O. Box 8129, 6700 EV
Wageningen, THE NETHERLANDS

CONTACT: F.A.R. van den Brock, Secretary
TYPE OF ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*

Scandinavian Federation for Laboratory Animal Science

Enheten för försöksdjursvetenskap och service
Medicinska Forskningsrådet
Box 7151
S-103 88 Stockholm, SWEDEN

TELEPHONE: +46 8454 4281/77
FAX: +46 8454 4303
WORLD WIDE WEB: http://www.uib.no/vivariet/SCANDLAS.html
CONTACT: Barbro Salomonsson
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES: Publishes the quarterly journal *Scandinavian Journal of Laboratory Animal Science.* Conducts annual meetings and publishes conference papers and abstracts in its journal.
COSTS: Journal subscriptions are Dkr. 250/individual; library subscriptions are Dkr. 600 + postage.

Schweizerische Gesellschaft für Versuchstierkunde (SGV)
Société Suisse pour la Science des Animaux de Laboratoire
Swiss Laboratory Animal Science Association

c/o RCC Registration and Consulting Co.
Landstrasse 33
4452 Itingen, SWITZERLAND

CONTACT: Ludwig G. Ullmann, Secretary or Dr. Marianne Geiser Kamber, President (e-mail: geiser@ana.unibe.ch)
WORLD WIDE WEB: http://www.unizh.ch/labtier/sgv.htm
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals*, an international journal devoted to issues surrounding the care and use of laboratory animals. Sponsors seminars and conferences and publishes the resulting papers and abstracts.

REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Universities Federation for Animal Welfare

8 Hamilton Close
South Mimms, Potters Bar,
Hertfordshire, EN6 3QD, UK
TELEPHONE: 01707-658202
FAX: 01707-649279
E-MAIL: trevor.poole@ucl.ac.uk
CONTACT: Victoria Taylor, Development Officer
TYPE OF INSTITUTION/ORGANIZATION: Private, charitable
RESOURCES/SERVICES: Publications, reprints, videos, educational brochures, and advisory services. Publishes a quarterly scientific journal entitled *Animal Welfare*, which brings together information from zoos, laboratories, farms, wild, and companion animals.
REQUESTOR: Anyone.
COSTS: Vary according to materials. Annual subscriptions to the journal *Animal Welfare* cost £50/US$100.

SUPPLIERS and PRODUCTS

Agri-Engineering, Inc. 2600 College Avenue, Goshen, IN (Indiana) 46526, USA. Tel: (219) 533-0497 or (800) 447-2751 (USA only).
Manufacturer of Plastic Piggy Playballs.

Ancare Corp. 2647 Grand Ave., P.O. Box 814, Bellmore, NY (New York) 11710-0814, USA. Tel: (800) 645-6379, Fax: (516) 781-4937.
Supplier of Nestlets, a rodent nesting material.

B & K Universal Ltd. The Field Station, Grimston Aldborough Hull, North Humberside HU11 4QE, UK. Tel: 01964 527555, Fax: 01964 527006.
Product line includes:

- disposable cardboard tubes for smaller mammals
- wooden chew blocks for rabbits and guinea pigs
- Beekay Litterite bedding
- different shaped food treats for primates

Big Dutchman International GmbH. P.O. Box 1163, D-49360 Vechta, GERMANY. Tel: +49 4447 8010, Fax: +49 4447 801237.
Manufacturer of Gather-all Breeder Nest System that is designed to safely handle eggs from the bird to the collection belt while providing comfort to the hen.

Bio-Serv. P.O. Box 450, Frenchtown, NJ (New Jersey) 08825, USA.Tel: (800) 473-2155, Fax: (800) 473-2167.
Manufacturer or distributor of a variety of environmental enrichment products for dogs, swine, rabbits, and primates. Product line includes:

- **Dogs**
  - Pen Pals which are treats developed to enhance socialization programs
  - Certified Rawhide Bone is designed for toxicology labs performing strict diet studies. The bone is assayed and chemically screened to ensure it is 100 percent rawhide. The bone helps control tartar and serves as an enrichment tool.
  - distributer for Kong toys for dogs

- **Swine**
  - Oinkers which are treats developed to reduce stress associated with handling and other procedures

- P.R.A.N.G. which is an oral rehydrator useful in post-operative care
- distributor of Kong toys for swine

- **Rabbits**
  - Rabbit Stix which are treats containing papain to help prevent hairballs
  - distributor of Kong toys for rabbits

Booda Products, Inc. 26707 Agoura Road, Suite 110, Calabasas, CA (California) 91302, USA. Tel: (818) 878-3900, Fax: (818) 878-3909.
Makers of a variety of toys for dogs, cats, and birds. Product line includes:

- **Dogs**
  - rope tugs with different attached objects for chewing and pulling provide for dental health
  - Booda Velvets which are chew toys made from corn-derived products

- **Cats**
  - rope toys
  - scratching posts and mats
  - cat furniture
  - litter boxes

- **Birds**
  - perches for all cage sizes

Boomer Ball. 24171 West Route 120, Grayslake, IL (Illinois) 60030, USA. Tel: (703) 546-6125 or (800) 858-9529.
Makers of non-toxic, heavy-duty, polyethylene plastic balls, mazes, ice floes and other devices. For use with small mammals to large carnivores and apes.
Product line includes:

- Boomer Ball--intended for soccer-style play, to encourage healthful exercise as an alternative to destructive chewing, pacing, and other undesirable behaviors. The ball has a rigid sidewall which is resistant, but not impervious, to chewing and scratching. The roughened surface on a used ball may be smoothed with a carpenter's rasp, file, or rough sandpaper. The ball is hollow, and the 10 inch and 20 inch diameter balls have a screw-out plug which allows insertion of pebbles, bells, etc. to produce an enticing noise, or sand or water to add weight.

- Ferret and Small Animal Ball--a 10" diameter ball for use in cages for chinchillas, guinea pigs, ferrets, and hedgehogs. The ball provides a maze-like play area with plenty of ventilation if the animal chooses to sleep inside the ball.

- Ferret Hide "N" Seek Maze Logs--a 16" long, 4½ diameter log-shaped tube with 4" openings at each end and two 4" openings on the side. The units can be snapped together to form unlimited maze configurations for small animals, such as ferrets, chinchillas, and guinea pigs and other small rodents.

- Bobbins--a round, hollow, spool-shaped, heavy polyethylene play/exercise toy for larger breeds of dogs and exotic animals.

Braden Industries. P.O. Box 2010, Sulphur Springs, TX (Texas) 75483, USA. Tel: (903) 439-3233 or (800) 272-3361 (US only), Fax: (903) 439-1814.
Manufacturer of the Braden Start Dry Feed Bottle that allows calves to be weaned to dry feed by suckling a rubber nipple and receiving pelletted feed rather than liquid.

Britz-Heidbrink, Inc. P.O. Box 1179, Wheatland, WY (Wyoming) 82201-1179, USA. Tel: (307) 322-4040, Fax: (307) 322-4141.
Produces animal housing systems that include "enrichment panels" that use color, noise reduction, thermal neutral surfaces, and opportunities for animal exploration.

Eisers. 360 Kiwanis Boulevard, Hazelton, PA (Pennsylvania) 18201, USA. Tel: (800) 526-6987 (USA only) or (717) 450-6130, Fax: (800) 680-3926 (USA only) or (717) 455-1593.
Manufacturer and distributor of the Giant Stallmate Apple, a scented toy for horses and pigs, and the Equi-Ball, a toy for horses.

Ethical, Inc. 216 First Street, Newark, NJ (New Jersey) 07107, USA. Tel: (201) 484-1000.
Manufacturer of solid vinyl chew toys for dogs and Squish balls for cats.

Jansen Engineering and Construction Company. Mercuriusweg 25, 3771 NC Barneveld, THE NETHERLANDS. Tel: +31 3420 21020, Fax: +31 03420 21019.
Manufacturer of Jansen automatic roll-away nests for hens. The shape, color, and floor material of the nest have been chosen according to the latest research in bird behavior.

K.L.A.S.S. 4960 Almaden Expressway, Suite 233, San Jose, CA (California) 95118, USA. Tel: (408) 266-1235.
Distributor of environmental enrichment products including Kong Toys, Boomer Balls, Nylabone, mouse nesting box, and a variety of easily sanitized play objects for birds, cats, dogs, ferrets, pigs, and primates. Product line includes:

- **Birds** (all items made of acrylic)

- rattles, swings, log 'n' chain, playring, hoops, chains, playhouse, mirrors, ladders and other toys

- **Cats**
  - Bizzy Kitty Home Entertainment Center
  - Sokker ball made of plastic
  - mini-Sox
  - Sparkel ball

- **Dogs, Pigs, and Primates**
  - Kong Toys in all varieties and shapes
  - Nylabone products such as plaque attacker dental ball, all sizes of nylabones, gumabones, nylarings, tug toys, rubber knots, and gumaballs.

- **Ferrets**
  - Ferret Ball

Landmeco A/S. DK-6870 Ølgod, DENMARK. Tel: +45 75 24 55 11, Fax: +45 75 24 43 53.
Manufacturer of the Landmeco Nest. Each roll-away nest contains six nest pads that provide the hens with a warm and comfortable laying area.

Wm. Lillico & Son (Wonham Mill) Ltd. Wonham Mill, Betchworth, Surrey, RH3 7AD, UK. Tel: 01737 247666, Fax: 01737 246783.
Produces a variety of forage mixes and is a distributer of Boomer Balls and the Scanbur A/S rabbit cage. Other products include:

- honey and sunflower rolls for rabbits
- paper wool for nesting, fine paper shavings for bedding or nesting, and Enviro-Dri which is a comfortable bedding designed specifically for large animals, canines, and primates.

P.J. Murphy Forest Products Corp. P.O. Box 300, 150 River Rd., Montville, NJ (New Jersey) 07045, USA.Tel: (201) 316-0800, Fax: (201) 316-9455.
Produces "Sani-Chips" animal bedding. Hardwood and softwood products are available.

Nylabone Products. Third Avenue and Union St, Neptune, NJ (New Jersey) 07753, USA. Tel: (908) 988-8400.
Manufacturer of Nylabone, Nylaballs, Gumabone Plaque Attacker, Gumabone tugs, and Gumadisc Flying Disc chew toys for dogs and other animals.

David Nunn Ltd. Station Yard, Hadnall, Shrewsbury, Shropshire SY4 3DD, UK. Tel: 0939 210555, Mobile: 0836 224691.
Distributors of Sundown Livestock Bedding and Environmental Straw Products. Poultry bedding is available in 25 kg poly-wrapped bales of de-dusted, sterilized straw.

R.J. Patchett, Ltd. Queensbury, Bradford, Yorkshire BD13 1DS, UK. Tel: 0274 882331, Fax: 0274 816362.
Manufacturer of laying cages with perch frames designed to meet EC welfare requirements. Also make nest boxes.

Primate Products. 1755 East Bayshore Rd., Suite 28A, Redwood City, CA (California) 94063, USA. Tel: (415) 368-0663, Fax: (415) 368-0665.
Produces "Kong Toys" which are autoclavable hollow toys that are durable enough to withstand rough handling and biting. They can also be filled with treats. Recommended for primates, canines, pigs, and rodents.

Rappa Fencing Ltd. Steepleton Hill, Stockbridge, Hampshire SO20 6JE, UK. Tel: 01264 810665, Fax: 01264 810079.
Manufacturer of eight- line electric fence system designed specifically for free range poultry.

Renco. Unit K1A, Bath Road Trading Estate, Stroud, Glos, England GL5 3QF, UK. Tel: 01453 752154, Fax: 01453 752155.
Manufacturer of electric netting for free range poultry. Offers protection from predators and provides bird control.

Scanbur A/S. Gl. Lellingegård, Bakkeleddet 9, Lellinge, DK-4600 Køge, DENMARK. Tel: +45 56 82 02 21 or 020 79 52 44 (Sweden only), Fax: +45 56 82 14 05.
Manufacturer of environmentally enriched caging systems for rabbits. Allows for single, pair, or group housing of rabbits. This cage system increases the possibility of exercise and physical activity. Rabbits can obtain social contact with fellow rabbits, and they can retire and hide whenever they want to. Each cage contains a resting shelf and shelter. Scandinavian distributor for Special Diet Services.

Shepherd Specialty Papers. P.O. Box 804, Kalamazoo, MI (Michigan) 49005, USA. Tel: (616) 324-3017 or (800) 382-5001(USA only) , Fax: (616) 324-3026 or (800) 222-5170 (USA only) .
Manufacturer of ALPHA-dri (alpha cellulose) which is a loose animal bedding of precisely defined composition. Also produce Enviro-Dri which is a bedding developed for pen-housed primates, large animals, and canines. Enviro-Dri is also recommended for the nesting of all animals.

Société Parisiennes des Sciures. 33, rue de Gode, 95100 Argenteuil, FRANCE. Tel: 39 80 15 09, Fax: 39 80 66 64, Telex: 688214 F.
Distributor of Litalabo bedding for laboratory animals.

Special Diet Services. P.O. Box 705, Witham, Essex, CM8 3AD, UK. Tel: 01376 511260, Fax: 01376 511247.
Manufacturers of diets in mixed shapes and sizes.

Tapvei. 73600 Kaavi, FINLAND. Tel: +358 71 688 88 99, Fax: +358 71 663 234.
Manufacturer of Tapvei bedding, bedding dispensers and waste removal systems, items for cage enrichment and Aspen bricks for dogs, rabbits, and rodents.

Common Enrichment Devices and Programs

BIRDS

Balls (leather, rubber, plastic or tennis)
Cage space to allow wing flapping
Cocoa husks
Colored objects
Dustbaths
Foraging litter or substrate
Grain blocks
Litter
Mirrors
Music
Nest building material
Nest boxes
Operant feeders (singly housed birds)
Pecking targets
Perches
Pre-formed nests
Roll-away nest box
Roosting shelves
Shredded paper
Social groups
Straw substrate
Wood shavings

CATS

Balls
Bedding materials
Bells
Catnip toys
Climbing frames
Colony housing
Sheepskin mice
Perches
Climbing poles
Human interaction
Movable toys
Music
Puzzle boxes
Elevated resting spaces
Ropes
Scratching posts
Shelves
Social housing
Stuffed toys
Vertical space
Viewing panels

DOGS

Balls
Bedding
Bones
Chew toys
Exercise
Gumabone chews
Human interaction
Knotted cloth
Novel objects
Nylabone frisbees
Nylabones
Plastic decoys
Rawhide
Resting boards
Ropes
Socialization
Tug toys
Walks

FARM ANIMALS

Cattle

Bedding
Fitting barriers
Human-Animal Interaction
Manipulable objects
Novel objects
Operant Food Devices
Social Housing

Horses

Foraging material
Grazing areas
Hanging Balls
Human-animal interaction
Novel objects
Social housing
Substrates (straw, wood shavings, etc.)

Sheep and Goats

Social or natural grouping
Bedding or substrate (straw)
Mirrors
Climbing structures (rocks or wood structures)

Swine

Balls
Bedding (straw, wood chips)
Chains
Edinburgh Foodball
Forage material (hay)
Free-range
Group housing
Heated floor mats
Hoses
Human-animal interaction
Knotted cloth
Manipulatable devices
Music
Novel objects
Plastic jugs
Pre-formed nests
Ropes
Scented plastic apples
Substrates (straw, wood chips, sand, etc)
Tires
Turn-around farrowing crate

FERRETS

Balls
Bite cups
Crickets
Foraging devices
Fur covered movable toys
Hide-and-seek tunnels
Mazes
Moving prey-models
Music
Nest boxes
Plastic burrows
PVC tubes
Shelters
Swimming pans

RABBITS

Balls
Bedding (straw, wood chips)
Burrows
Free range
Fresh fruits or vegetables
Gnawing objects
Group housing
Hide-boxes
Manipulatable objects (wood)
Music
Nest boxes
Nesting material
Pair housing (except adult males)
PVC pipe
Resting shelf
Roughage or Forage (hay, straw)
Varied diet

RODENTS

Bedding
Burrows
Cage dividers
Climbing accessories
Climbing frame
Exercise devices (running wheels)
Film canisters
Foraging devices
Funnel
Gnaw blocks or sticks
Group or social housing (not hamsters or adult males)
Hide boxes
Ladders
Mazes
Music
Nest boxes or nest-building material - (hay, tissues, or wood-wool)
Platforms
PVC pipe
Ramps
Shelves
Shuttle box
Tubes
Tunnels

SUBJECT INDEX

Birds

Cats

Dogs

Farm Animals

Cattle

Horses

Sheep and Goats

Swine

Ferrets

Rabbits

Rodents

Hamsters and Gerbils

Guinea Pigs

Mice

Rats

Wild Rodents

United States Department of Agriculture
National Agricultural Library
Public Services Division
Beltsville, Maryland 20705

Document Delivery Services Available to Libraries, Other Information Centers and Commercial Organizations.

The National Agricultural Library (NAL) accepts requests from libraries and other organizations in accordance with the national and international interlibrary loan code and guidelines. In its national role, NAL supplies copies of agricultural materials not found elsewhere.

Submit requests to state/region/network sources prior to sending to NAL. Within the United States, possible sources are public libraries, land-grant university libraries or other large research libraries within a state. In other countries submit requests to major university, national or provincial institutions. If the needed publications are not available from these sources, submit requests to NAL with a statement indicating their non-availability.

Requests — Submit on the American Library Association (ALA) or the International Federation of Library Associations and Institutions (IFLA) interlibrary loan form or via electronic mail or telefacsimile (see over for more details). Include the complete name of the person authorizing the request on each form; the standard bibliographic source which lists the title as owned by NAL; and the call number if the citation is from an NAL database (CAIN/AGRICOLA, *Bibliography of Agriculture*, or the NAL catalog).

Loan Service — Materials in the NAL collection are loaned only to U.S. libraries. The loan period is one month. Loans may be renewed for an additional month if there is no reserve. Make renewal requests in writing or by calling prior to the due date. The borrowing library is responsible for any loss or damage to the material from time of dispatch.

The following materials are **not** available for loan: serials (except for USDA serials); rare, reference, and reserve books; microforms; and proceedings of conferences or symposia. Photocopy or microform of the non-circulating publications is supplied automatically (as described below) when the requesting organization indicates that photocopy is acceptable on the loan form.

Audiovisuals (AVs) — Order at least 3-4 weeks before the intended show date. Give show date and alternate show date when requesting specific titles. Request specific format needed if more than one format is given in the citation.

Document Delivery Service — Submit a separate completed interlibrary loan form for each article required. Indicate willingness to pay charges on the form and compliance with copyright law or include a statement that the article is for "research purposes only". Requests are not processed without these statements.

Charges:

- Photocopy, hard copy of microfilm and microfiche – $5.00 for the first 10 pages or fraction copied from a single article or publication. $3.00 for each additional 10 pages or fraction.
- Duplication of NAL-owned microfilm – $10.00 per reel.
- Duplication of NAL-owned microfiche – $5.00 for the first fiche and $ .50 for each additional fiche per title.

Billing – Charges include postage and handling, and are subject to change. Invoices are issued quarterly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. Establishing a deposit account with NTIS is encouraged. ***DO NOT SEND PREPAYMENT.***

Send Requests to:

USDA, National Agricultural Library
Document Delivery Services Branch, ILL, PhotoLab
10301 Baltimore Blvd., NAL Bldg.
Beltsville, Maryland 20705-2351

Contact the Head, Document Delivery Services Branch at (301) 504-5755 or via Internet at ddsbhead@nalusda.gov with questions or comments about this policy.

United States Department of Agriculture | National Agricultural Library | Public Services Division | Beltsville, Maryland 20705

Document Delivery Services Available to Foreign Libraries, Information Centers and Commercial Organizations.

The National Agricultural Library (NAL) accepts requests from libraries and other organizations in accordance with the national and international interlibrary loan code and guidelines. In its national role, NAL supplies copies of agricultural materials not found elsewhere.

Submit requests to major university libraries, national or provincial institutions or network sources prior to sending requests to NAL. If the needed publications are not available from these sources, submit requests to NAL with a statement indicating their non-availability.

AGLINET — Requesters in countries with an AGLINET library are encouraged to make full use of that library and its networking capabilities. As an AGLINET participant, NAL provides free document delivery service for materials published in the United States to other AGLINET participants.

Requests — Submit requests on the American Library Association (ALA) or the International Federation of Library Associations and Institutions (IFLA) interlibrary loan form or via electronic mail or telefacsimile (see over for more details). Include the complete name of the person authorizing the request on each form; the standard bibliographic source which lists the title as owned by NAL; and the call number if the citation is from an NAL database (CAIN/AGRICOLA, *Bibliography of Agriculture*, or the NAL catalog).

Document Delivery Service — Submit a separate completed interlibrary loan form for each article requested. Indicate willingness to pay charges on the form, and compliance with copyright law or include a statement that the article is for "research purposes only". Requests cannot be processed without these statements.

Charges:

- Photocopy, hard copy of microfilm and microfiche – $5.00 for the first 10 pages or fraction copied from a single article or publication. $3.00 for each additional 10 pages or fraction.
- Duplication of NAL-owned microfilm – $10.00 per reel.
- Duplication of NAL-owned microfiche – $5.00 for the first fiche and $ .50 for each additional fiche per title.

Billing – Charges include postage and handling, and are subject to change. Invoices are issued quarterly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. Establishing deposit account with NTIS is encouraged. Annual billing is available to foreign institutions on request by contacting NAL at the address below. ***DO NOT SEND PREPAYMENT.***

Send Requests to:

USDA, National Agricultural Library
Document Delivery Services Branch, ILL,PhotoLab
10301 Baltimore Blvd., NAL Bldg.
Beltsville, Maryland 20705-2351

Contact the Head, Document Delivery Services Branch at (301) 504-5755 or via Internet at ddsbhead@nalusda.gov with questions or comments about this policy.

United States Department of Agriculture

National Agricultural Library

Public Services Division

Beltsville, Maryland 20705

Document Delivery Services to Individuals

The National Agricultural Library (NAL) supplies agricultural materials not found elsewhere to other libraries. Submit requests first to local or state library sources prior to sending to NAL. In the United States, possible sources are public libraries, land-grant university or other large research libraries within a state. In other countries submit requests through major university, national, or provincial institutions.

If the needed publications are not available from these sources, submit requests to NAL with a statement indicating their non-availability. Submit one request per page following the instructions for libraries below.

NAL's Document Delivery Service Information for the Library

The following information is provided to assist your librarian in obtaining the required materials.

Loan Service — Materials in NAL's collection are loaned only to other U.S. libraries. Requests for loans are made through local public, academic, or special libraries.

The following materials are not available for loan: serials (except USDA serials); rare, reference, and reserve books; microforms; and proceedings of conferences or symposia. Photocopy or microform of non-circulating publications may be purchased as described below.

Document Delivery Service — Photocopies of articles are available for a fee. Make requests through local public, academic, or special libraries. The library will submit a separate interlibrary loan form for each article or item requested. If the citation is from an NAL database (CAIN/AGRICOLA, *Bibliography of Agriculture,* or the NAL Catalog) and the call number is given, put that call number in the proper block on the request form. Willingness to pay charges must be indicated on the form. Include compliance with copyright law or a statement that the article is for "research purposes only" on the interlibrary loan form or letter. Requests cannot be processed without these statements.

Charges:

- Photocopy, hard copy of microfilm and microfiche – $5.00 for the first 10 pages or fraction copied from a single article or publication. $3.00 for each additional 10 pages or fraction.
- Duplication of NAL-owned microfilm – $10.00 per reel.
- Duplication of NAL-owned microfiche – $ 5.00 for the first fiche and $ .50 for each additional fiche per title.

Billing – Charges include postage and handling, and are subject to change. Invoices are issued quarterly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. Establishing a deposit account with NTIS is encouraged. *DO NOT SEND PREPAYMENT.*

Send Requests to:

USDA, National Agricultural Library
Document Delivery Services Branch,PhotoLab
10301 Baltimore Blvd., NAL Bldg.
Beltsville, Maryland 20705-2351

Contact the Head, Document Delivery Services Branch at (301) 504-5755 or via Internet at ddsbhead@nalusda.gov with questions or comments about this policy.

USDA - NATIONAL AGRICULTURAL LIBRARY
ELECTRONIC ACCESS FOR INTERLIBRARY LOAN (ILL) REQUESTS

The National Agricultural Library (NAL), Document Delivery Services Branch accepts ILL requests from libraries via several electronic methods. All requests must comply with established routing and referral policies and procedures. A sample format for ILL requests is printed below along with a list of the required data/format elements.

ELECTRONIC MAIL - (Sample form below)

SYSTEM	ADDRESS CODE
INTERNET	LENDING@NALUSDA.GOV
OCLC	NAL's symbol AGL need only be entered once, but it must be the last entry.

SAMPLE ELECTRONIC MAIL REQUEST

AG University/NAL ILLRQ 231 1/10/95 NEED BY: 2/15/95

Interlibrary Loan Department
Agriculture University Library
Heartland, IA 56789

Dr. Smith Faculty Ag School

Canadian Journal of Soil Science 1988 v 68(1): 17-27
DeJong, R. Comparison of two soil-water models under semi-arid growing conditions

Ver: AGRICOLA Remarks: Not available at AU or in region.
NAL CA: 56.8 C162 Auth: C. Johnson CCL Maxcost: $15.00

Ariel IP = 111.222.333.444.555 Or Fax To 123-456-7890

TELEFACSIMILE - 301-504-5675. NAL accepts ILL requests via telefacsimile. Requests should be created on standard ILL forms and then faxed to NAL. NAL fills requests via FAX as an alternative to postal delivery at no additional cost. If you want articles delivered via fax, include your fax number on your request. NAL will send up to 30 pages per article via fax. If the article length exceeds 30 pages NAL will ship the material via postal service. All requests are processed within our normal timeframes (no RUSH service).

ARIEL - IP Address is 198.202.222.162. NAL fills ILL requests via ARIEL when an ARIEL address is included in the request. NAL treats ARIEL as an alternative delivery mechanism, it does not provide expedited service for these requests. NAL will send up to 30 pages per article via Ariel. If the article length exceeds 30 pages or cannot be scanned reliably, NAL will deliver the material via fax or postal service.

REQUIRED DATA ELEMENTS/FORMAT

1. Borrower's address must be in block format with at least two blank lines above and below so form may be used in window envelopes.
2. Provide complete citation including verification, etc. and NAL call number if available.
3. Provide authorizing official's name (request will be rejected if not included).
4. Include statement of copyright compliance (if applicable) & willingness to pay NAL charges.